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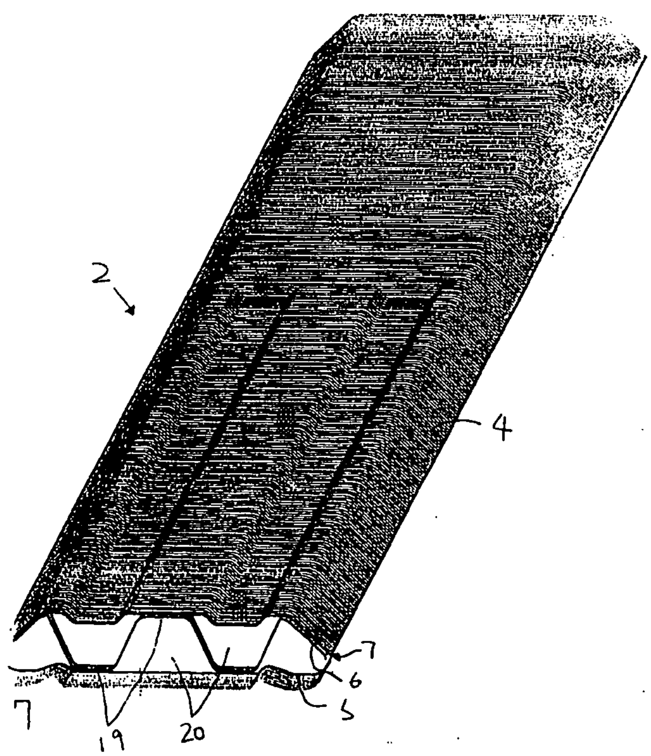
(57) Abstract

A hollow core board for use in various sports and a method of forming the same are provided. A hollow core board comprises a top outer-shell panel and a bottom outer-shell panel that are disposed generally parallel to each other. The top and bottom outer-shell panels have longitudinal axes. A performed corrugated inner panel is sandwiched between and bonded to the top and bottom outer-shell panels so as to form a plurality of longitudinal cavities between the top and bottom outer-shell panels, parallel to the longitudinal axes of the outer-shell panels. The resulting structure is largely hollow. The longitudinal cavity provided inside the board may be used as: a water chamber to control buoyancy of a board used in water sports; a centrifugal ballast chamber comprising a tube having centrifugal ballast, the centrifugal ballast traveling inside the tube when the board is spun due to centrifugal force, or a reinforcing rod chamber for housing fiberglass or graphite rod to adjust stiffness of the board. The longitudinal cavity may also be used for housing a removable fin system or a fully adjustable foot binding system.



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HOLLOW CORE TECHNOLOGY

Field of the Invention

The present invention relates to a corrugated hollow core board technology and its related consequent features and, more specifically, a hollow core board especially suitable for use in various boarding sports such as wakeboarding, snowboarding, water-skiing, snowskiing, surfing, etc.

Background of the Invention

Currently, manufacturers in the boarding sports industry generally use solid core compression molding technology. Solid core compression molding technology is a process typically used to make fiberglass wakeboards, snow skis, and kneeboards. For water-sport boards (e.g., wakeboards), the core is of relatively low density material (e.g., closed-cell polyurethane foam core), and for snow-sport boards (e.g., snowskis, snowboards), the core is of relatively high density material (e.g., fiberglass, metal, or composites). In either case, the entire core is essentially solid, with no cavities within the board structure.

A less common but known method of board construction, is the aluminum honeycomb composite technology. The honeycomb composite technology is occasionally used for making lightweight snowskis. This process uses an aluminum honeycomb core and high-strength composite combined in a vacuum bagging process. The process is time consuming and expensive. Moreover, although the resultant structure is lightweight, because the honeycomb is crushed during manufacture of the skis, the resulting structure is it not very strong. Further, since each honeycomb cell is very small, they serve no useful non-structural functions.

Boards produced by either of the two methods are either solid or predominantly solid, and thus relatively heavy, rigid, and susceptible to breaking during use. Also, because they are solid or predominantly solid, it is difficult or impossible to provide certain fixtures and features for improved versatility, adjustability and performance that would be possible and convenient if the boards were not predominantly solid.

A need exists for a technology for manufacturing a board that is light, flexible, strong, inexpensive to produce, and has improved adjustability, versatility, performance and additional features as described below.

Summary of the Invention

The present invention provides a corrugated hollow core board technology and related features and improvements. A corrugated hollow core board comprises a top outer-shell panel and a bottom outer-shell panel that are disposed in planes generally parallel to each other. The top and bottom outer-shell panels each have a longitudinal axis, which are also disposed generally parallel to each other. A performed corrugated inner panel is interposed between and bonded to the top and bottom outer-shell panels so as to define a plurality of longitudinal cavities between the top and bottom outer-shell panels, parallel to the longitudinal axes of the outer-shell panels. The resulting structure, thus, is largely hollow.

The plurality of longitudinal cavities created within the hollow core board make it possible to couple various functions and features which are not possible, or at least not practical or efficiently obtained with conventional solid core or honey-combed boards. For example, one or more of the longitudinal cavities may be used as a water chamber, a centrifugal ballast chamber, or a reinforcing rod chamber, or may be used for housing a removable fin system or a slidably- and rotatably-adjustable foot binding system. Each of these systems and chambers, as will be appreciated in the descriptions below, are either much more difficult, or virtually impossible, to incorporate practically into conventional solid core sporting boards.

The water chamber is formed by providing openings on both ends of a longitudinal cavity so that water will flow into and out of the longitudinal cavity. The water chamber thus formed functions to control buoyancy of the board when used in water sports, by letting in water while the board is stationary and draining the water once the board is in motion. Thus, while the board is stationary, it will submerge more, and more easily, enabling the user to stand upright more easily. Conversely, as the board begins to travel, the water chamber drains, and the board rises closer to the

surface. The rate of buoyancy adjustment can be adapted by varying the size and number of openings, or by varying the ratio of size or number of openings in the front (fore) of the board to the size or number of openings in the rear (aft) of the board.

The centrifugal ballast chamber is interposed within a longitudinal cavity, is closed at each end, and contains movable centrifugal ballast. The centrifugal ballast in current embodiments would typically comprise ball bearings or liquid. When a board containing the centrifugal ballast chamber is flipped or spun during use, the centrifugal ballast radiates toward either or both ends of the centrifugal ballast chamber due to centrifugal force, thereby enhancing the momentum of the rotation.

In another embodiment of this portion of the invention, the centrifugal ballast chamber may also be used in a hollow shaft, for example, a hollow golf club having centrifugal ballast elastically connected to its proximal (gripping) end. When a user swings such a club, the centrifugal ballast flies toward the distal end of the club due to centrifugal force, thereby enhancing the momentum of the swing. Likewise, the centrifugal ballast portion of the invention could be embodied in any sporting board or equipment which is rotated in use.

The reinforcing rod chamber is interposed within a longitudinal cavity, has an opening at either or both ends, and a removable plug or other means for sealing the opening. The opening allows a reinforcement rod to be inserted into and removed from the longitudinal reinforcing rod chamber cavity. In current embodiments, the rod has a length that runs substantially throughout the length of the reinforcing rod chamber. By inserting one or more rods into one or more reinforcing rod chambers provided in one or more longitudinal cavities of the board, a user can reinforce and adjust the rigidity of the board according to the particular application and preferences. Also, by including holes within the walls of the corrugated panel at appropriate intervals, the reinforcement rod chamber within the board can be oriented diagonally, or even perpendicularly relative to the longitudinal cavities and the longitudinal axes of outer-shell panels. For example, the board can be made stiffer in general, stiffer on one side, flexed concavely, flexed convexly, or otherwise varied in its shape, flexure or stiffness depending on the functional properties desired by the user. As one example in a wakeboard embodiment, if a certain user tends to favor his or her left side, the board can be curved slightly and made stiffer by insertion of a reinforcing rod on the right side, diagonally, or otherwise, to compensate for the user's inclination. In this manner the board is more customizable to specific users, and more versatile.

The removable fin system includes a fin box to be housed inside a longitudinal cavity, and a fin to be removably coupled to the fin box. Because the cavity for housing the fin box is pre-formed in the board, the removable fin system can be conveniently installed in the board..

The slidably and rotatably-adjustable foot binding system includes at least one pair of parallel rails secured on the top outer-shell panel. The rails are mounted over and along two parallel longitudinal cavities. The rails slidably support a bottom clamp plate. The bottom clamp plate supports a foot plate thereon, and the foot plate is angularly and rotatably adjustable with respect to the bottom clamp plate. A top clamp plate is placed over the foot plate, to bind the foot plate and the rails between the top and bottom clamp plates. As a result of the binding system arrangement the user can adjust the position of the binding in three ways not presently available in prior boards. In the context of a wakeboard or snowboard embodiment of the invention, these three adjustment advantages manifest themselves as follows.

First, the user can adjust the binding to any point fore or aft along the continuous line parallel with and formed by the rails mounted on the board. In contrast with conventional wakeboards, the user may only place the binding at those specific points delimited and defined by a single pair of colinear preset holes. Second, in a wakeboard embodiment of this portion of the present invention, the users may adjust the degree of rotation of their binding, within a plane parallel to the plane of the top outer panel, but relative to the axes of the outer panels in continuous increments. Again, in conventional wakeboards, the user may only rotate the binding to those points delimited and defined by a single pair of colinear preset holes. Third, in conventional wakeboards, the binding is mounted flat to the top outer panel. In the current embodiment of this portion of the present invention, however, the binding may be tilted at various angles in any direction relative to the top outer panel. Fourth, in conventional wakeboards the binding is only secured by two bolts and the boot and foot have a tendency to rock or pivot (on the line defined by those two bolts) relative to the board. In contrast, in the current embodiment of the present invention, the user's feet won't tilt or rock relative to the board.

In addition to being much more versatile and adjustable than conventional binding systems, the binding system portion of the present invention is also much stronger. In conventional binding systems, each binding is secured to the board with only two bolts, and if even just one of them fails, serious injury to the user is likely to result. In contrast, with the present invention, each binding is secured to the board

with at least four bolts and sometimes eight, and at least two or three of them must fail for a crash to result. Moreover, unlike conventional boards, the bolts securing the binding to the board are connected to a rail which distributes the force exerted on the binding relatively uniformly throughout the length of the board. In contrast, the force exerted on the bolt in conventional boards is transmitted to a single, or a single pair of discrete threaded housings, and the force is not distributed. Further, because conventional boards are generally constructed with a solid polyurethane foam core, the threaded housing holes are secured by relatively weak material. In contrast, with the present invention, the bolts are secured by rails, which in turn are secured to the interior longitudinal corrugation, resulting in forces exerted on the binding being better distributed to the structure of the board, and hence developing more strength. The same advantages can be applied to snowboard embodiments, and, to a lesser extent, water-skis and snowskis.

The water chamber, the centrifugal ballast chamber, the reinforcing rod chamber, the removable fin system, and the slidably- and rotatably-adjustable foot binding system portion of the invention, as described above, may also be used, albeit without some of the advantages, in connection with conventional boards that are currently available, such as foam core boards.

The corrugated hollow core board of the present invention is light, strong, and relatively inexpensive to manufacture. Furthermore, the hollow core board makes it possible to conveniently attach various adjustability, versatility and performance features and other portions of the invention to the board, as described above.

Brief Description of the Drawings

The foregoing aspects and many of the attendant advantages of this invention will become more readily appreciated by reference to the following detailed description, when taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a perspective view of the hollow core board according to the present invention;

FIGURES 2A-2C illustrate a method of forming top and bottom outer-shell panels;

FIGURES 3A-3D illustrate another method of forming top and bottom outer shell panels;

FIGURES 4A and 4B illustrate a method of sealing the seam of a board;

FIGURES 5A and 5B illustrate another method of sealing the seam of a board;

FIGURES 6A-6C illustrate yet another method of sealing the seam of a board;

FIGURE 7 is a partial cross-sectional view of a hollow core board of the present invention;

FIGURES 8A and 8B are examples of the hollow core board constructed in accordance with the present invention;

FIGURES 9 illustrates a reinforcing rod chamber containing a longitudinal rod within;

FIGURE 10 is a plan view of a wakeboard constructed of the hollow core board of the present invention, including a removable fin system and an adjustable binding system;

FIGURES 11A and 11B are end cross-sectional views illustrating the construction of the removable fin system of the present invention;

FIGURES 12A and 12B are a side view and an end view, respectively, of a fin;

FIGURES 13A and 13B are a side view and an end view, respectively, of a fin inserted in a fin box;

FIGURES 14 is a cross-sectional view of a spring-loaded detent used to secure a fin in a fin box;

FIGURES 15A-15D illustrate another embodiment of a removable fin system, including a fin defining a fin head with a plurality of projections;

FIGURES 16A and 16B are top cross-sectional views of spring-loaded double detents used to secure a fin head with a plurality of projections in a fin box;

FIGURE 17 is an example of a mechanism for releasing a fin head of FIGURE 15A from a fin box;

FIGURE 18 is a plan view of a pair of rails slidably supporting a bottom clamp plate, used to support an adjustable foot plate;

FIGURES 19A and 19B are end cross-sectional views of a board, illustrating a process of installing a pair of rails to the board;

FIGURES 20A and 20B are side cross-sectional views of a board, illustrating a process of installing a pair of rails to the board;

FIGURES 21A-21C illustrate a method of mounting an external element to a hollow core board;

FIGURES 22A-22D illustrate another method of mounting an external element to a hollow core board;

FIGURES 23A-23C illustrate yet another method of mounting an external element to a hollow core board;

FIGURES 24A-24C illustrate the construction of a slidably- and rotatably-adjustable binding system;

FIGURE 25 illustrates the longitudinal adjustability of a bottom clamp plate and a foot plate along a pair of rails;

FIGURE 26 illustrates the angular adjustability of a foot plate relative to a pair of rails;

FIGURES 27A-27C illustrate the use of a thumb screw to secure a foot plate to a hollow core board; and

FIGURE 28 illustrates pads inserted beneath a foot plate to adjustably raise the foot plate relative to a hollow core board surface.

Detailed Description of the Preferred Embodiment

Referring to FIGURE 1, a hollow core board 2 of the present invention comprises a top outer-shell panel 4 and a bottom outer-shell panel 5 that are disposed generally parallel to each other. A performed corrugated panel 6 is sandwiched between the top and bottom outer-shell panels 4 and 5. Longitudinal seams 7 of the hollow core board 2, where all three panels 4 and 5, and 6 meet, are sealed against air or moisture entering into the interior of the board 2. The corrugated panel 16 has a plurality of longitudinal ridges 19. The longitudinal ridges 19, together with the outer-shell panels 4 and 5, define a plurality of longitudinal cavities 20 running the length of the board 2 and, thus, the board 2 is largely hollow. It should be understood that the shapes or surface geometry of the panels 4 and 5, and 6 are not limited to that illustrated in FIGURE 1, but may take various other forms depending on the desired properties of the board.

The outer-shell panels 4 and 5 and the corrugated panel 6 can be formed of almost any raw material, substrate, thermoplastic, or thermoset, such as wood, metal, paper, plastic, epoxy, styrene, vinyl, carbon fiber, fiberglass, and Kevlar. When fibrous material, such as fiberglass, is used, it is saturated with a binding agent, such as epoxy. The fibrous material is placed into a heated male/female match fit mold. In the alternative, a flat sheet of various material, as described above, may be pre-heated in a separate oven, and introduced into a heated male/female match fit mold.

As a further alternative, corrugated panel 6 and outer-shell panels 4 and 5 may be formed by a vacuuming method. Specifically, the fibrous material described above is drawn by vacuum onto a male mold or a female mold to form a panel. When a flat

sheet of material is used, the material is pre-heated in a separated oven before being vacuum formed onto a male mold or a female mold. Once a panel is formed using any of the above described methods, its flashing excess is trimmed off.

FIGURES 2A through 2C illustrate another method of forming top and bottom outer-shell panels 4 and 5. As shown in FIGURE 2A, fibrous material, or pre-heated flat sheets of material, as described above, are placed into a female/female mold 12. An inflated or inflatable air bag 13 is positioned between the sheets. As illustrated in FIGURE 2B, top and bottom outer-shell panels 4 and 5 are formed around the air bag 13. FIGURE 2C illustrates top and bottom outer-shell panels 4 and 5 removed from the mold 12. The outer-shell panels 4 and 5 may be formed simultaneously, as described above, or may be formed separately by using only one sheet of material at a time. As before, once the outer-shell panels 4 and 5 are cooled, their excess flashing is trimmed off.

FIGURES 3A through 3D illustrate yet another method of forming top and bottom outer-shell panels 4 and 5. As before, material or sheets of material for top and bottom outer-shell panels 4 and 5 are placed into a female/female mold 12. An epoxy plug 14 of a shape corresponding to the shape of the mold cavity is positioned between the sheets. As before, top and bottom outer-shell panels 4 and 5 may be formed simultaneously. As an alternative, the two outer-shell panels 4, 6 may be formed separately one at a time. Once the outer-shell panels 4,5 have cooled, their excess flashing is trimmed off.

The outer-shell panels 4 and 5 and the corrugated panel 6, once formed, are prepared to be bonded together. Specifically, surface areas to be bonded are prepared by sandblasting, hand sanding, mechanical sanding, or chemical preparation (spraying, wiping, brushing, or dipping) or other methods known in the art. The bonding surfaces may further undergo primer preparation (e.g. spraying, wiping, brushing, or dipping). Application of a white or light colored primer to the inside surfaces of the outer-shell panels also enhances the appearance of graphics applied to the panels' outer surfaces. The bonding surfaces may also be prepared by bonding a film, a substrate, or a "Peel Ply" thereto to be used as a primer. For this purpose, Korad®acrylic film is suitable as both a mold release and a primer film. An adhesive material is applied to the prepared bonding surfaces. In embodiments where a window is provided in the outer-shell panels to enable viewing into the interior of a completed hollow core board, additional aesthetic treatment of the corrugated panel 6 may be desired. For example, graphics may be applied to corrugated panel 6 which

could be viewed through a window or windows included within either one or both of the outer-shell panels, thus enhancing the overall aesthetic appearance of the board and to emphasize its unique structure. Such interior graphics could be applied later in the process, but generally, applying them before the corrugated panel 6 is enclosed or sandwiched between the outer shell panels would be easier.

Next, the top and bottom outer-shell panels 4 and 5 and the corrugated panel 6 are assembled and bonded together to form a hollow core board 2. FIGURES 4A through 6C illustrate methods of sealing the longitudinal seams 7 of the board 2. As illustrated in FIGURES 4A and 4B, an adhesive 15 is applied to the mating bonding surfaces inside the longitudinal seam 7 of the board. The longitudinal edge 14 of the corrugated panel 6 underlaps the longitudinal seam 7 between the top and bottom outer-shell panels 4 and 5. The edge 14 of the corrugated panel 6 thus interiorly seals the seam 7. In the alternative, as illustrated in FIGURES 5A and 5B, the longitudinal seam 7 between the top and bottom outer-shell panels 4 and 5 may be sealed with a length of tape 16 consisting of fiberglass and epoxy.

FIGURES 6A through 6C illustrate a further alternative method of sealing the longitudinal seam 7. A length of low density foam 17, such as PVC or polyethylene, is wrapped by reinforcement fabric 18, such as fiber glass, and epoxy. In place of the length of low density foam, an elongate, inflatable air bladder (not shown) also wrapped by reinforcement fabric and epoxy, may be used. The foam length is pressed into the longitudinal cavity located adjacent the longitudinal seam 7 of the board 2. As illustrated in FIGURE 6B, a female/female mold 12 is used to bond all the panels together. Once cured, the length of foam fills the longitudinal cavity adjacent the seam 7, sealing the seam 7. This seam sealing method may also be used with other longitudinal cavities within the board 2 to add strength, or to secure and reinforce fin boxes or other board features.

Because ambient air expands and contracts with temperature fluctuation, it may be desirable to fill the hollow longitudinal cavities within the board with a gas that does not expand or contract as much as air. This could be done either while the mold is closing in the final assembly stage, or after the board is finished. It may also be advantageous to drill holes through the walls of the corrugated panel 6 to allow the expanding or contracting air to flow from one longitudinal cavity to the next. It may further be advantageous to drill a hole through one of the outer-shell panels 4 and 5 to allow trapped gas to escape, thus relieving pressure in the final assembly stage. Conversely, it may be desirable to inject gas through the same holes to increase

pressure within the canister. These holes would be sealed in most embodiments before using the board.

FIGURE 7 is a partial cross-sectional view of a hollow core board 2 produced in accordance with the corrugated hollow core technology as described above. The density or frequency of the longitudinal ridges 19 of the corrugated panel 6 across the cross-section may be varied so that such density is generally inversely proportional to the distance 21 separating the top outer-shell panel 4 and the bottom outer-shell panel 5. Specifically, in regions where the distance 21 between the top and bottom outer-shell panels 4 and 5 is smaller, the density or frequency of the longitudinal ridges 19 is larger, and vice versa. FIGURES 8A and 8B further illustrate examples of hollow core board 2 of various cross-sectional shapes constructed in accordance with the present invention, and the inverse relationship between longitudinal ridge frequency and distance 21 as it varies along the cross-section. This inverse relationship provides more uniform strength and rigidity across the board despite the distance 21 separating the top and bottom outer-shell panels 4 and 5. On the other hand, in some embodiments of the invention, it may be desirable for the strength and rigidity to vary, or be non-uniform. In such embodiments, the frequency of undulation in the corrugation, or put differently, the density of ridges 19, need not vary inversely proportional to distance 21, nor indeed vary at all.

In the currently preferred embodiments of the present invention, the longitudinal cavities 20 located inside the hollow core board 2 allow the board to absorb shock. Specifically, the hollow core is resiliently compressible and is also flexible. Therefore, the board can function like a spring to cushion landings. Additionally, since the hollow core board 2 is air tight, it can be inflated with an air pump to adjust its stiffness as well as its cushioning characteristics.

Furthermore, the longitudinal cavities 20 of the hollow core board 2 make it possible to add various versatility, adjustability and performance features to the board 2. In one embodiment, for a hollow core board 2 used in water, one or more longitudinal cavities 20 may include openings at its ends to form a water chamber. The end openings include siphon holes. In operation, the water chamber is filled with water while the board 2 is stationary in the water. This reduces the amount of flotation and helps to stabilize the board in the water when a user is getting up aboard. Also, for example, a water-ski or kneeboard having the water chamber may have the chamber partially filled with water at its back-half, so that the board's back-half will sit lower in the water to ensure the correct positioning of the board for take off. Once

the board is in motion, the water drains out through the siphon holes, and the board rises toward the surface. Accordingly, the water chamber serves to provide the board with controlled buoyancy. Furthermore, one or more of the water chambers can be configured to cause the board to assume an upright position in the water when the user falls off the board. For example, one or more of the water chambers can be situated non symmetrically relative to the boards such as at only one end, or on one side, and offset by corresponding air chambers, thus forcing one part of the board to tend to sink and the other to float. The board is thus easier to see in the water for both the user and boat operators. This increased visibility greatly enhances safety in the water. One or more water chambers may be provided and they may be situated forward, aft, stern, starboard, or in various combinations of the foregoing depending on the particular application. Also, depending on the particular application, to alter the rate of buoyancy adjustment and other operating characteristics, the size, shape, location, number and other properties of the end openings and siphon holes may be varied. Some of these variations will be fixed at the time of manufacture. However, by installing plugs, valves or other closure means for one or more of the siphon holes and/or water chamber end openings, the board users can themselves adjust certain of such properties as desired.

In another embodiment, a longitudinal cavity 20 is formed into a centrifugal ballast chamber having closed ends at both ends. The centrifugal ballast chamber is at least partially filled with centrifugal ballast. The centrifugal ballast can be in the form of ball bearings, liquid, or other appropriate substance. In operation, while the user of the board is riding forward, he puts more of his weight onto the back of the board and, thus, the centrifugal ballast moves to the back of the board. This helps stabilize the trailing edge of the board and keeps the leading edge up and out of the water. In addition, during a flip move, the centrifugal ballast moves forward or backward depending on the direction of the flip to amplify the momentum of the flipping motion. Furthermore, during a spin move or a 360-degree turn, the centrifugal ballast radiates away from the center of the board by centrifugal force toward one or both ends of the centrifugal ballast chamber, thereby amplifying the momentum of the spinning motion. This provides a "whip around" sensation to the user.

In one current embodiment, the centrifugal ballast chamber includes an inner wall to divide the chamber into two subchambers of a generally equal length. Both such subchambers contain roughly the same amount of centrifugal ballast. This ensures that the centrifugal ballast is equally allocated to the front and back of the

board during the spinning motion, thereby discouraging elliptical rotation. If the possibility of elliptical rotation is desired, the inner wall can be omitted. If elliptical rotation is preferred, the inner wall can be off center along the axial length of the longitudinal cavity. The inner wall in the centrifugal ballast chamber can be fixed in position at the time of manufacture or, if increased user versatility is desired, can be installed so as to be removable at the option of the user. For example, in one embodiment, the inner wall dividing the centrifugal ballast chamber into subchambers is mounted on an internal axle perpendicular to the plane of the board. The axle is affixed to a knob on the top outer panel surface turned by the user. When greater centrifugal or elliptical rotation is desired, the users may turn the knob thereby turning the inner wall to parallel with the longitudinal cavity and thereby opening the centrifugal ballast chamber in the manner of a gate valve. Conversely, if the user prefers to reduce or eliminate that feature, the inner wall knob may be turned some or all of the way needed to close the centrifugal chambers. Other means of adjusting or preventing the operation of the centrifugal ballast chamber may be employed. For example, if water is used as the ballast, a drain valve may be provided enabling the user to drain and refill the ballast chamber at will. It should be understood that many variations are available by changing the number, size and/or location of the subchambers and/or the weight, shape (if solid), viscosity (if liquid), location and/or removability and/or distribution of the centrifugal ballast, depending on the particular application. The centrifugal ballast chambers may be provided in, for example, wakeboards, snowboards, and kneeboards.

The centrifugal ballast chamber portion of the invention as described above has various other applications. For example, a golf club shaft may be provided with a hollow core inside. Centrifugal ballast, such as ball bearings and/or liquid, is provided inside the hollow core and elastically attached to the proximal end of the club. When a user swings the club, the centrifugal ballast flies toward the distal end of the club due to centrifugal force, increasing the weight and speed of the club head. This maximizes the momentum of the club head as it hits a ball. The same construction described above may be applied for example, in a baseball bat and a hockey stick.

The longitudinal cavity 20 may also be used as a reinforcing rod chamber to removably house a rod therein to adjust rigidity, flexure, curvature or stiffness of the board. FIGURE 9, which is a cross-sectional view of a hollow core board 2, illustrates the construction of a reinforcing rod chamber. A longitudinal molded holder 22 is fitted into and glued to the interior of a longitudinal cavity 20. At least

one end of the longitudinal cavity forming the reinforcing rod chamber includes an opening and a removable plug or closeable valve for sealing the opening. Through the opening, a fiberglass or graphite rod 23 may be inserted and removed. It is advantageous to form a plurality of reinforcing rod chambers in a board 2 so that users can adjust the stiffness, flexure and/or curvature of the board depending on their own preferences and operational bias.

For example, if more rigidity or stiffness is desirable, one or more rods 23 are inserted into one or more reinforcing rod chambers. If less rigidity is desirable, the rods 23 may be removed. Further, if rigidity at only one side of the board is desired, one or more rods may be inserted to only that side of the board. If a more concave, convex, or torsional board curvature is desired, appropriate combinations of reinforcing rods and rod chambers can be provided to accomplish these results.

Similarly, to enhance and modify the structural effect of certain reinforcing rods, the molded holder 22 can be configured to force a pre-defined curvature for tension or compression to the reinforcing rod. For example, in one embodiment at one of the ends of the rod chamber (or the molder holder 22) a threaded female housing is provided. Corresponding male threading is provided at the same end of the reinforcing rod such that the reinforcing rod can be screwed into the threaded female housing and fixably secured. At the opposite end of the rod chamber (or the molder holder 22) another rod housing is provided which houses the rod for rotation relative to rod chambers and the board. The rod itself is fixed with a fixed screw head cap which enables the rod to be axially rotated, but prohibits axial movement of the rod through the non-threaded rod housing. As a result of this configuration, clockwise axial rotation of the rod (by means of a screwdriver for example) will induce tension in the rod and consequent curvature (or strength adjustment) in the board. Such curvature is determined by the particular configuration of the rod chamber (or molded holder 22), the internal structure of the rod, or other variables. Conversely, compression can be induced in the rod with opposite or like results by reversing the rotation of the rod and/or configuring the non-threaded rod having to induce compression into the rod rather than tension.

The molded holder 22, illustrated in FIGURE 9, may also be used in forming a water chamber or a centrifugal ballast chamber described above to add strength to the interior of the longitudinal cavity, or to otherwise adapt the interior geometry of the cavity as may be desired for the particular chamber. Alternatively, the longitudinal cavities themselves may serve as the chambers.

With each and all of the water chamber, centrifugal ballast chamber, and reinforcing rod chamber formed of a longitudinal cavity, a transparent window may be provided on the top or bottom outer-shell panel along the longitudinal cavity. This allows the user to view the inside of the chambers, and their contents, if any, as the case may be. For example, it may be desirable for the user to be able to see whether a reinforcing rod is in a reinforcement rod chamber, or whether there is ballast in a centrifugal ballast chamber.

The water chamber, the centrifugal ballast chamber, and the reinforcing rod chamber described above may also be provided, albeit with loss of some advantages, with a conventional board, such as a foam core board.

As further alternatives, as illustrated in FIGURE 10, when a hollow core board 2 is applied, for example, as a wakeboard, a longitudinal cavity 20 provided in the board makes it possible to conveniently attach a removable fin system 26 and a slidably- and rotatably-adjustable foot binding system 27 to the board.

FIGURES 11A through 17 illustrate the construction of a removable fin system 26. Referring to FIGURES 11A and 11B, a fin box 28 is inserted into a longitudinal cavity 20 and bonded with an adhesive 15 at bonding surfaces (See FIGURE 14). The fin box 28 is formed of, for example, nylon by injection molding, and includes a slit 30 for receiving a fin 32. FIGURES 12A and 12B are a side view and an end view, respectively, of one example of the fin 32, which is typically cut from a flat sheet of graphite, titanium, or aluminum. The fin 32 includes a fin head 34, and the fin head 34 includes a slot 36 therethrough. FIGURES 13A and 13B are a side view and an end view, respectively, of the fin 32 inserted into and secured in the fin box 28. In this example, a spring-loaded detent 38 is used as a securing means, which is housed in the fin box 28. Specifically, the detent's spring-loaded ball pops into the slot 36 of the fin 32 upon complete insertion of the fin head 34 to the slit of the fin box 28. FIGURE 14 is a detailed view of the spring-loaded detent 38. Depending on the application, more than one spring-loaded detent 38 may be provided. It should be understood that the spring-loaded detent 38 as described above is illustrated as an example of securing means, and various other means of securing the fin 32 to the fin box 28 will be apparent to those skilled in the art.

FIGURES 15A through 17 illustrate another embodiment of a removable fin system 26. As before, the fin system 26 comprises a fin box 28 fitted and glued to a longitudinal cavity 20 in the board 2, and a fin 32 having a fin head 34. The fin head 34 includes a plurality of projections 40. Each projection 40 includes a slot 42

therethrough. The fin box includes a plurality of slits 43 for receiving the projections 40. The number of the slits 43 is greater than the number of the projections 40 so that the fin head 34 can be inserted to the fin box 28 at a varying relative position with respect to the fin box 28, as illustrated in FIGURES 15B through 15D.

Referring back to FIGURE 15A, the fin head 34 is secured to the fin box 28 with a spring-loaded double detent 44. FIGURE 16A is a top cross-sectional view of the fin head 34 secured to the fin box 28 by the spring-loaded double detent 44. The double detent 44 is housed inside the fin box 28, and includes two balls that are spring-loaded. Upon complete insertion of the projections 40 into the slits 43 of the fin box 28, the spring-loaded balls pop into two slots 42 provided through two projections 40 of the fin head 34. FIGURE 16B is an enlarged partial view of FIGURE 16A illustrating a detailed top view of a slit 43. As seen, a plurality of raised ridges 46 may be provided on the inner surface of the slit 43. The raised ridges 46 serve to tightly secure the fin head 34 inserted into the slit 43.

FIGURE 17 illustrates an embodiment of a mechanism for releasing the fin head 34 from the fin box 28. A spring-loaded lock release button 48 disposed within a button guide 50 is provided within the fin box 28. When pressed, the lock release button 48 enters between the fin head 34 and the spring-loaded double detent 44 to separate the two, thereby releasing the fin head 34 from the double detent 44 and, hence, from the fin box 28.

It should be understood that the spring-loaded double detent and the spring-loaded lock release button as described above are illustrated as alternative embodiments, and various other means for securely attaching and removing the fin head 34 to and from the fin box 28 may be utilized by those skilled in the art without departing from the spirit and scope of the invention.

Although the removable fin system described above is more easily and efficiently used with the corrugated hollow core portion of the invention, it may also be used albeit with loss of some advantages with a conventional board, such as a foam core board, by installing the fin box within the board. In such embodiments, the fin box is connected to the foam core rather than to a longitudinal cavity of a hollow core board.

As illustrated in FIGURE 10, when a hollow core board 2 of the present invention is utilized to form a wakeboard or snowboard, a pair of slidably- and rotatably-adjustable foot binding systems 27 may be conveniently attached to the board 2.

FIGURES 18 through 28 illustrate detailed construction of the foot binding system 27. FIGURE 18 is a plan view of a pair of lipped channel rails 52 securing, overlapping and supporting a slidable bottom clamp plate 54 therebetween. FIGURES 19A-19B, and 20A-20B, are end views and side views, respectively, illustrating the attachment of the rails 52 to the top outer-shell panel 4 of the board. In currently preferred embodiments, the top outer-shell panel 4 is molded to include an indent 58 of a generally rectangular shape (See FIGURE 26) so as to recess the binding system such that its highest points are flush with most of the top outer panel 4. In other embodiments the binding system may be raised above or lowered below flush relative to the top outer shell panel depending on the performance characteristics desired.

Referring again to FIGURES 18 and 19B, preferably three or more threaded holes 60 are provided over and along a longitudinal cavity 20 for supporting and securing each rail 52 to the board. Referring to FIGURES 20A and 20B each rail 52 includes corresponding holes 62 therethrough such that, when the rail 52 is placed over and along the longitudinal cavity 20, holes 62 provided through the rail 52 are aligned with the three threaded holes 60 provided along the longitudinal cavity 20. Screws 64 run through the holes 62 and the threaded holes 60 to secure the rail 52 to the top outer-shell panel 4, as shown in FIGURE 20B.

In addition to that shown in FIGURES 20A and 20B various other methods are available for mounting external components, such as the rails 52, to the top outer-shell panel 4 of the board 2. FIGURES 21A through 21C illustrate one such method. In FIGURE 21A, an anchor 65 made of plastic, wood, or metal, is installed in a longitudinal cavity 20. In FIGURE 21B, a hole 66 is drilled through the anchor 65. In FIGURE 21C, a threaded insert 68, such as a screw, is inserted into the drilled hole 66 to secure an external element to the board 2. An alternative method is illustrated in FIGURES 22A through 22D. As in FIGURE 22A, a hole 70 is drilled over a longitudinal cavity 20. A blind fastener 72, such as rivets, rivet nuts, rivet bolts, molly nuts, molly bolts, expansion nuts, or expansion bolts are inserted through the hole 70 to secure an external element to the board 2. As illustrated in FIGURE 22D, a reinforcement strip 73 may be used when added insert retention strength is desired. Yet another alternative method of securing an external element to the board is illustrated in FIGURES 23A through 23C. In FIGURE 23A, an extruded receiver 74 made of plastic, wood, or metal, having an opening, is installed within a longitudinal cavity 20. In FIGURE 23B, a hole 76 is drilled through the top outer-shell panel 4 so

as to coincide with the opening of the extruded receiver 74. As illustrated in FIGURE 23C, an external element 79 can be inserted, indexed, rotatably-inserted, or positioned by hand into the receiver 74.

However the rails 52 are secured to the top outer panel surface 4, they are also configured to secure a slidable bottom clamp plate 54. The assembly of the bottom clamp plate 54 and the rails 52 are illustrated in end cross-sectional view FIGURE 24A. The bottom clamp plate 54 includes lateral projections 80 at its both ends. The projections 80 are mated with corresponding indents provided along the length of both rails 52. Thus, the bottom clamp plate 54 is secured just above the top outer surface 4 of the board 2, but is also slidable between the rails 52, throughout the length of the rails 52. It should be understood that the above-described construction is given for illustrative purposes, and various other constructions are available to slidably attach the bottom clamp plate 54 to the rails 42. However bottom clamp plate 54 is slidably attached to rails 52, bottom clamp plate 54 is also configured to adjustably secure foot plate 56.

FIGURES 24B through 28 illustrate: (a) adjusting the position (fore or aft on the board 2) of the bottom clamp plate 54 relative to the rails 52; (b) adjusting the plan-view angular rotational orientation of the foot plate 56 relative to the bottom clamp plate 54; and (c) fixating both the bottom clamp plate 52 and the foot plate 56 to the rails 52.

Referring to FIGURE 24B, the bottom clamp plate 54 includes two threaded holes 81 at both its ends adjacent the projections 80. In operation, a user can slidably adjust the bottom clamp plate 54 to its desired position (more or less fore or aft) relative to the rails 52, as illustrated in FIGURE 25. Referring back to FIGURE 24B, over the bottom clamp plate 54, the user places a foot plate 56. As illustrated in FIGURE 25, the foot plate 56 includes a plurality of circularly arranged slots 82 therethrough. As illustrated in FIGURE 26, by changing which portion of which slots 82 are aligned with the two threaded holes 81 provided through the bottom clamp plate 54, the user can vary the plan-view angular rotational orientation of the foot plate 56 relative to the bottom clamp plate 54. The range of plan-view angular rotational orientation adjustment can be varied depending on the particular application. For example, for wakeboard purposes, it has been found satisfactory to vary the plan-view angular rotational orientation of the foot plate 56 between ±34 degrees relative to a horizontal axis 87 that lies between and is perpendicular and roughly coplanar with the two pairs of the rails 52.

Again referring back to FIGURE 24B, over the foot plate 56, a top clamp plate 84 including two holes 86 at its both ends is placed, to be aligned with the bottom clamp plate 54. At this point, the holes 86 provided through the top clamp plate 84, the slots 82 provided through the foot plate 56, and the holes 81 provided through the bottom clamp plate 54 are all aligned. The user screws two thumb screws 88 into the aligned holes 86 and slots 82 and 81. Referring to FIGURE 24C, as the thumb screws 88 are tightened, the top clamp plate 84 and the bottom clamp plate 54 bind the foot plate 56 and the rails 52 therebetween, thereby fixating the foot plate 56 to the rails 52, both with respect to fore and aft position, and with the degree of plan-view angular rotational orientation.

FIGURES 27A through 27C are detailed illustrations of one embodiment of the thumb screw 88. As illustrated in FIGURE 27B, the thumb screw 88 in one embodiment has an access hole 89 provided at its head. In that embodiment an Allen wrench 90 is inserted into the access hole 89 to tighten and loosen the thumb screw 88, as illustrated in FIGURES 27B and 27C. Thus, by merely loosening the thumb screws 88 slightly, a user can quickly and easily: (a) slide either foot forward or backward (fore or aft) on the board; (b) slide both feet closer together or farther apart; (c) rotate either foot or both feet more or less perpendicular to the longitudinal axis (roughly the direction of travel) of the board; and/or (d) any combination of the above. After the desired position (in all of the foregoing respects) is selected, that position is then fixed simply by tightening the thumb screws 88.

Another important and novel aspect of the foregoing adjustability features of the invention is that within a specified range, the adjustment increment possibilities are infinite. More specifically, referring again to FIGURE 26, and in light of the foregoing explanation, it will be understood that foot plate 56 can be rotated as far clockwise or counterclockwise as will be permitted by the arc length of slots 82. The arc length of slots 82 is limited only by the strength of the foot plate 56 (and that the foot plate must be one piece; that is, the slots cannot be a complete circle). That is, with sufficiently strong foot plate material, the slots' arc length could be much greater than that illustrated in FIGURE 26. However long or short the slots' arc length, within the range of rotation thereby defined and delimited, the foot plate 56 can be rotated to virtually any position, and is not, as in the prior art, restricted to a finite number of positions defined by a finite number of discrete, non-continuous points. Thus, the user can adjust the angular rotational orientation to the exact preferred position.

Likewise, unlike the prior art binding, which can only accommodate positioning the foot at certain positions defined by discrete predetermined holes in the board, with the present invention, the user's foot can be positioned at an infinite number of increments within the range defined by the rails. Specifically, referring to FIGURE 25, foot plate 56 begins in position A, but can be moved forward distance d1 to position A1 or backward a distance d2 to position A2. It should be understood from the foregoing that distance d2 and d1 are limited only by the length of rails 52, and that the rails 52 may be any length desired, up to and including the entire length of board 2. It should further be understood that however long are the rails 52, and consequently the distances d1 and d2, the foot plate can be positioned at virtually any point along the length of rail 52. That is, with the present invention, the user is not restricted in fore and aft binding adjustment to only certain pre-defined points.

FIGURE 28 is a longitudinal cross section of board 2 which illustrates another adjustability aspect of the binding system 27 of the present invention. Pads 92 and 94 are inserted between the foot plate 56 and the bottom clamp plates 54. The pads 92 and 94 may be formed of any suitable material preferably having shock-absorbing characteristics, such as rubber. The pads 92 and 94 serve to elevate the foot plate 56 relative to the board 2 so as to allow the foot plate 56 to flex during use. Furthermore, the pads 92 and 94 themselves have shock-absorbing function. Also, by providing pads 92, 94 of different thickness, the foot plate 56 can be sloped with respect to the surface of the board 2, as illustrated in the example of FIGURE 28. In wakeboarding and other board sports, it is often desirable to have a front foot plate slightly sloping up forward, and a rear foot plate slightly sloping up rearward in order to stabilize the user's positioning aboard. The user can easily make such adjustment, by simply changing the thickness, size, or number of pads to be used on each of the bottom clamp plates 54. In alternative embodiments of the invention, adjusting the angle of the foot plate can be accomplished by mounting rails 52 at an angle relative to board 2, and/or by providing curved rails 52. For example, in applications of the invention where constantly sloping the foot plate relative to the board is more important, or otherwise desirable rails 52 can be continuous over a substantial portion of board 2 and can be curved concavely relative to the top-outer-shell panel (when the board is upright), so that the curve roughly follows an arc circumscribed by a radius the length of the average user's leg, so as to compensate for the angle of inclination imposed on the bottom of the user's foot as a result of separating the feet from one

another on the board 2. Thus, as the user's feet separate from one another, the rails curve upward thereby elevating and tilting the feet toward each other.

Accordingly, the binding system 27 of the present invention allows for unlimited and infinite increments of: (a) longitudinal slidability, (b) angularly rotatable orientation, and (c) height and angle adjustments of the foot plate 56 relative to the board 2.

Although optimum adjustability and strength of the binding system 27 are obtained using the entire binding system 27, foot plate 56 can also be used with prior art boards. Specifically, prior boards have a single row of holes running generally longitudinally down the center of the board. As a result, some of the strength and the infinite incremental adjustment of binding system 27 are not possible because foot plate 56 can only be secured to the specific predetermined holes. Nevertheless, even with prior boards, the plan-view angular rotational orientation remains infinitely incrementally adjustable with the foot plate 56 of the present invention. Further, as illustrated in the example of FIGURE 28, by providing pads 92 and 94 of different thickness, the foot plate 56 can be sloped with respect to the surface of the board 2, even in conjunction with prior boards with a single line of holes. Thus foot plate 56 is compatible with existing boards and their conventional binding systems.

Similarly, the binding system as described above may also be used, albeit with loss of some advantages, with a conventional board, such as a foam core board. In such embodiments, the rails 52 would be secured to the top surface of the board and secured by reinforcing within the interior of the board rather than secured to housing within a longitudinal cavity 20 or to a longitudinal ridge 19 of corrugated panel 16 as with the present invention.

The hollow core technology as described above has a variety of applications. Alternate embodiments or applications of one or more aspects of the invention include: water skis, knee boards, snow skis, snow boards, surf boards, boogie boards, skim boards, sail boards (including mast, boom, keel, and fin), skate boards, boat oars and paddles, diving boards, helmets, shin guards, catcher's masks, personal watercraft hulls, boat hulls, airplane wings, prop blades, body panels, kayaks and canoes hulls, sail boats (including mast, boom, and keel), automobile brush guards, bullet-proof vests and other body armor, fins, composite bicycle frames, centrifugally ballasted fishing poles, composite electric guitar bodies and necks, vehicle roll and crash bars, and composite ski rope handles.

While the preferred embodiment of the invention has been illustrated and described, it will be appreciated that various changes can be made therein without departing from the spirit and scope of the invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A hollow core board including:

first and second outer-shell panels disposed generally parallel to each other;

a corrugated inner panel having a plurality of longitudinal ridges and disposed between the first and second outer-shell panels and bonded to the outer-shell panels, so as to form a plurality of longitudinal cavities between the first and second outer-shell panels, each longitudinal cavity having both ends; and

at least one feature selected from the group consisting of (a) at least one water chamber, the water chamber comprising one of the longitudinal cavities, both ends of the water chamber cavity including openings for passing water therethrough; (b) at least one centrifugal ballast chamber, the centrifugal ballast chamber comprising one of the longitudinal cavities, both ends of the centrifugal ballast chamber cavity being closed, the cavity forming the centrifugal ballast chamber containing centrifugal ballast inside that can travel throughout the length of the cavity; (c) at least one reinforcing rod chamber, the reinforcing rod chamber comprising one of the longitudinal cavities, at least one of both ends of the reinforcing rod chamber cavity including an opening and a plug for sealing the opening, the reinforcing rod chamber further including a rod removably inserted into the reinforcing rod chamber cavity; (d) a removable fin system comprising a fin box and a fin, the fin box fitted into one of the longitudinal cavities, the fin defining a fin head, the fin head removably secured in the fin box by a spring-loaded detent; and (e) at least one adjustable foot binding system comprising at least one pair of rails, a bottom clamp plate, and a foot plate, the pair of rails attached to the top outer-shell panel along two of the longitudinal cavities, the rails slidably supporting the bottom clamp plate therebetween, the bottom clamp plate supporting the foot plate thereon, the foot plate provided for supporting a user's foot, the bottom clamp plate including a securing means for fixating the bottom clamp plate to the rails at a desired position.

2. The hollow core board of Claim 1, wherein the openings at both ends of the longitudinal cavity forming the water chamber include siphon holes.

3. The hollow core board of Claim 1, wherein the centrifugal ballast inside the longitudinal cavity forming the centrifugal ballast chamber is selected from the group consisting of ball bearings and liquid.

4. The hollow core board of Claim 1, wherein the longitudinal cavity forming the centrifugal ballast chamber includes at least one axially provided block wall to divide the longitudinal cavity into at least two subchambers, each subchamber including centrifugal ballast that can travel throughout the length of the subchamber.

5. The hollow core board of Claim 1, wherein the removable rod is made of material selected from the group consisting of fiberglass and graphite.

6. The hollow core board of Claim 1, wherein the density of the longitudinal ridges of the corrugated inner panel at a portion of the board is inversely proportional to the distance separating the first and second outer-shell panels at the same portion.

7. The hollow core board of Claim 1, wherein the exterior surface of the board is air tight.

8. The hollow core board of Claim 1, wherein the longitudinal cavity formed into the feature selected from the group consisting of the water chamber, the centrifugal ballast chamber, and the reinforcing rod chamber, includes a transparent window provided through at least one of the outer-shell panels.

9. The hollow core board of Claim 1, wherein the fin head defines a plurality of projections and the fin box includes a plurality of slits for receiving the projections, the number of the slits being greater than the number of the projections to allow for adjustable positioning of the fin head in the fin box.

10. The hollow core board of Claim 1, wherein the securing means for fixating the bottom clamp plate to the rails comprises:

a top clamp plate placed over the foot plate, the top clamp plate including at least one hole therethrough;

the foot plate including at least one slot therethrough;

the bottom clamp plate including at least one hole therethrough;

the rails slidably supporting the bottom clamp plate being bound between the bottom clamp plate and the foot plate; and

at least one thumb screw inserted through the hole of the top clamp plate, the slot of the foot plate, and the hole of the bottom clamp plate for binding the foot plate and the rails between the top and bottom clamp plates.

11. The hollow core board of Claim 10, wherein the foot plate includes at least two slots therethrough.

12. The hollow core board of Claim 1, which further includes at least one removable pad inserted between the foot plate and the bottom clamp plate.

13. The hollow core board of Claim 12, wherein the foot plate is supported by at least two bottom clamp plates, each of the bottom clamp plates supporting at least one removable pad inserted between itself and the foot plate, so as to elevate the foot plate relative to the bottom clamp plates.

14. A board used in water sports including at least one longitudinal water chamber, the water chamber extending inside and throughout the length of the board and having both ends, the both ends including openings for passing water therethrough.

15. The board of Claim 14, wherein the openings at both ends of the water chamber include siphon holes.

16. The board of Claim 14, wherein the water chamber further includes a transparent window provided through the surface of the board.

17. A board including at least one longitudinal centrifugal ballast chamber, the centrifugal ballast chamber extending inside and throughout the length of the board and having both ends, the both ends being closed, the centrifugal ballast chamber containing centrifugal ballast inside that can travel throughout the length of the chamber.

18. The board of Claim 17, wherein the centrifugal ballast is selected from the group consisting of ball bearings and liquid.

19. The board of Claim 17, wherein the centrifugal ballast chamber includes at least one axially provided block wall inside to divide the longitudinal cavity into at least two subchambers, each subchamber including centrifugal ballast that can travel throughout the length of the subchamber.

20. The board of Claim 17, wherein the centrifugal ballast chamber further includes a transparent window provided through the surface of the board.

21. A board including at least one reinforcing rod chamber, the reinforcing rod chamber extending inside and throughout the length of the board and having both ends, at least one of the ends including an opening and a plug for sealing the opening, the reinforcing rod chamber further including at least one rod removably inserted into the reinforcing rod chamber.

22. The board of Claim 21, wherein the rod is made of material selected from the group consisting of fiberglass and graphite.

23. The board of Claim 21 which includes a plurality of reinforcing rod chambers.

24. The board of Claim 21, wherein the reinforcing rod chamber includes a transparent window provided through the surface of the board.

25. A removable fin system to be mounted onto a board, the fin system comprising:

a fin including a fin head; and

a fin box to be fitted into the board, the fin box including a slit for receiving the fin head, the fin box further including a spring-loaded detent for removably securing the fin head in the fin box.

26. The fin system of Claim 25, wherein the fin head includes a plurality of projections, and the fin box includes a plurality of slits for receiving the projections, the number of the slits being greater than the number of the projections to allow adjustable positioning of the fin head in the fin box.

27. An adjustable foot binding system to be mounted onto a board, the binding system comprising:

at least one pair of rails;

a bottom clamp slidably supported by the rails;

a foot plate for supporting a user's foot supported by the bottom clamp plate; and

means for securing the bottom clamp plate to the rails at a desired position.

28. The binding system of Claim 27, wherein the means for securing the bottom clamp plate to the rails comprises:

a top clamp plate placed over the foot plate; the top clamp plate including at least one screw hole therethrough;

the foot plate including at least one slot therethrough;

the bottom clamp plate including at least one screw hole therethrough;

the rails slidably supporting the bottom clamp plate being bound between the bottom clamp plate and the foot plate; and

at least one thumb screw inserted through the screw hole of the top clamp plate, the slot of the foot plate, and the screw hole of the bottom clamp plate for binding the foot plate and the rails between the top and bottom clamp plates.

29. The binding system of Claim 28, wherein the foot plate includes at least two slots therethrough.

30. The binding system of Claim 27, which further includes at least one removable pad inserted between the foot plate and the bottom clamp plate.

31. The binding system of Claim 30, wherein the foot plate is supported by at least two bottom clamp plates, each of the bottom clamp plates supporting at least one removable pad inserted between itself and the foot plate, so as to elevate the foot plate relative to the bottom clamp plates.

32. A hollow shaft having a proximal end and a distal end, the shaft containing centrifugal ballast inside, the centrifugal ballast being elastically attached to the proximal end of the shaft.

Fig. 1

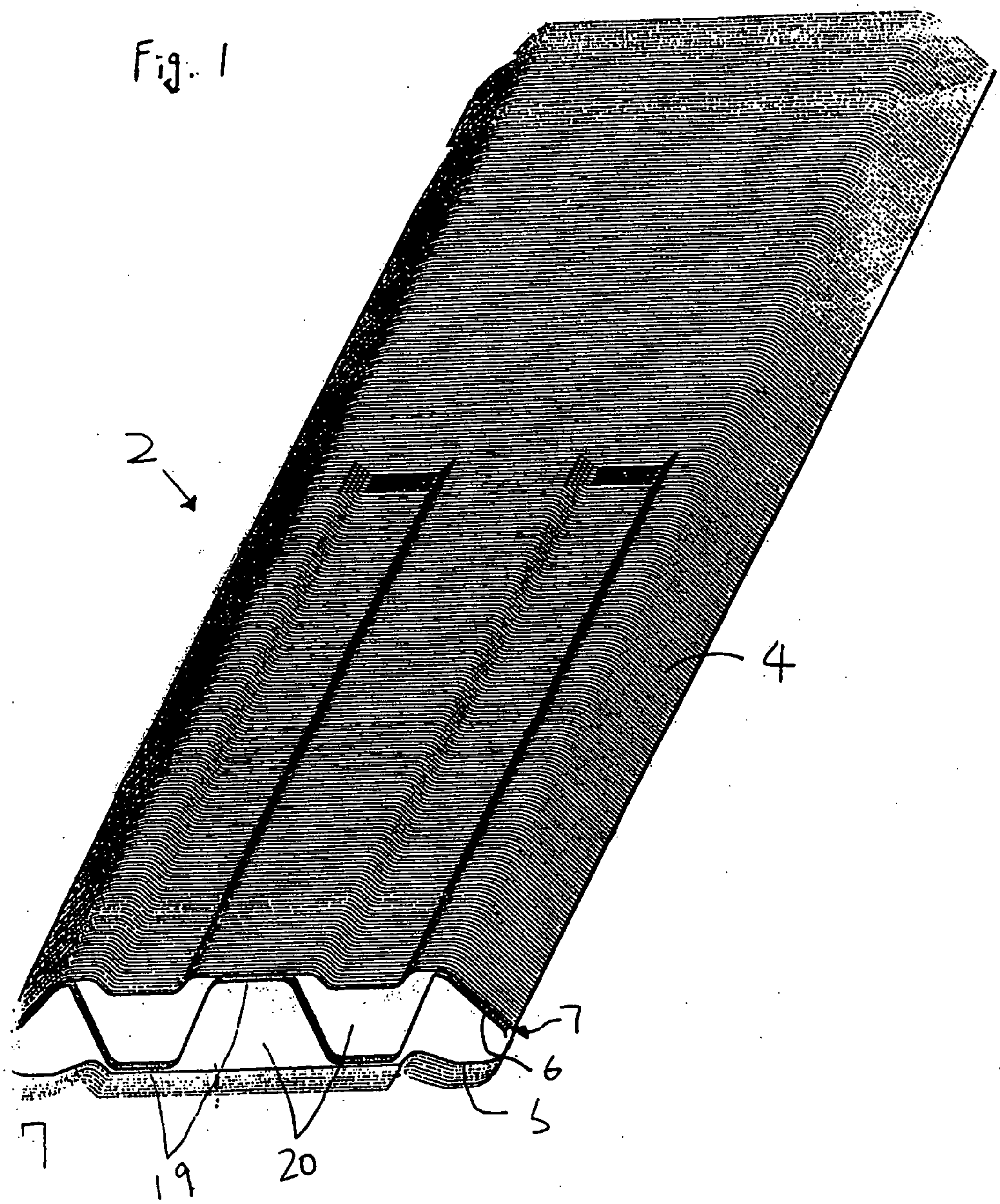


Fig 2A

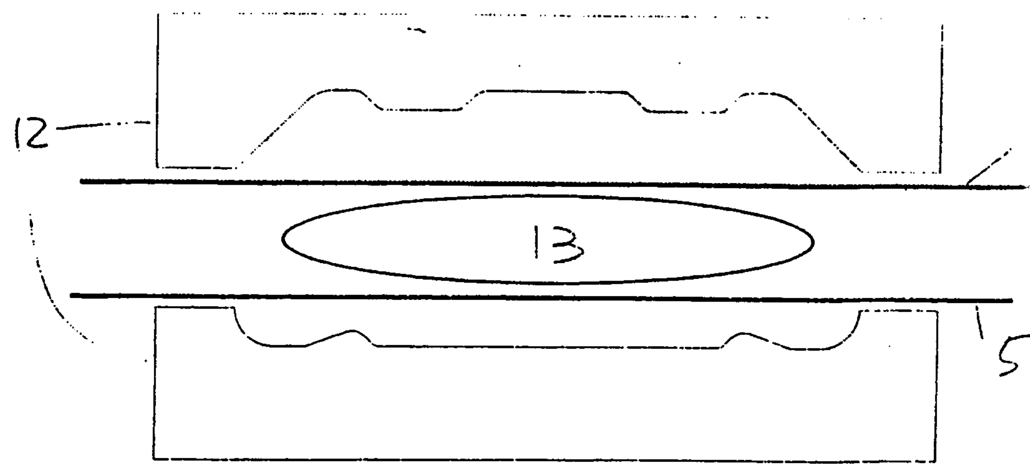


Fig. 2B

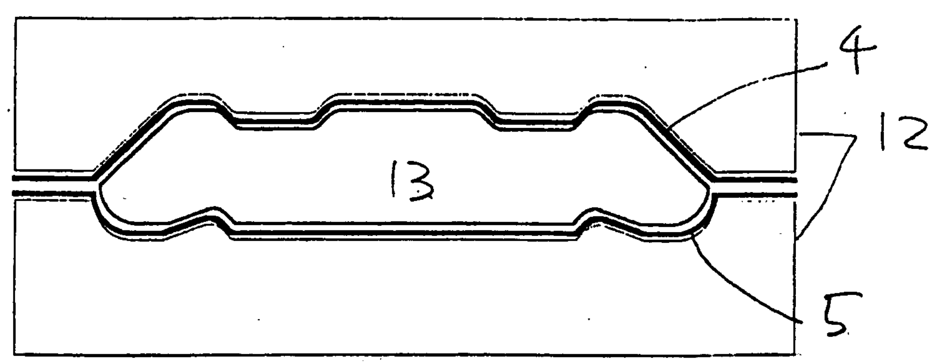


Fig. 2C

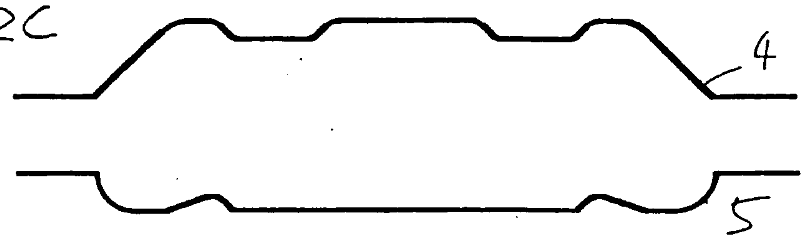


Fig. 3A

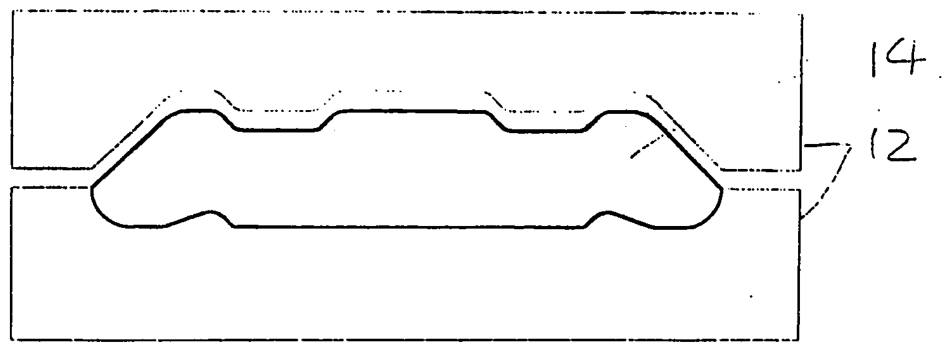


Fig. 3B

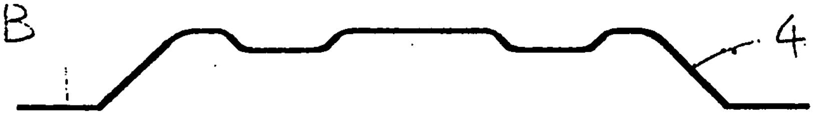


Fig. 3C

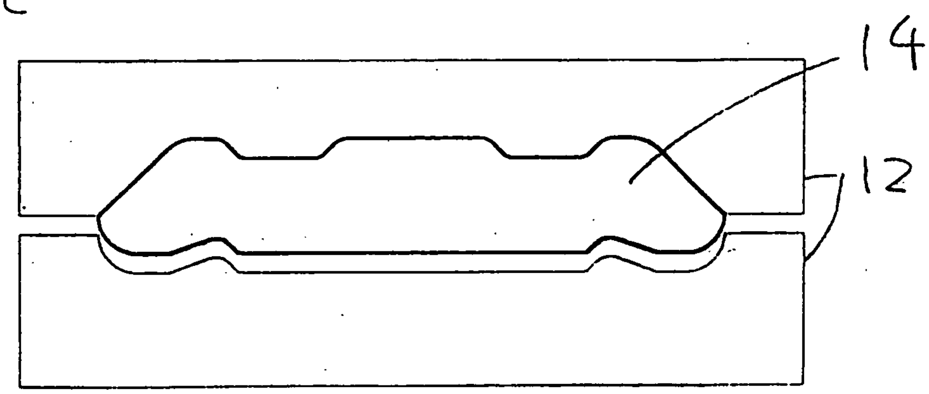


Fig. 3D

Fig 4A

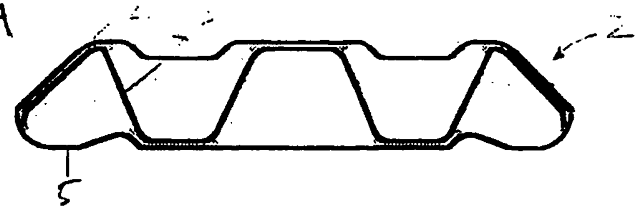


Fig. 4B

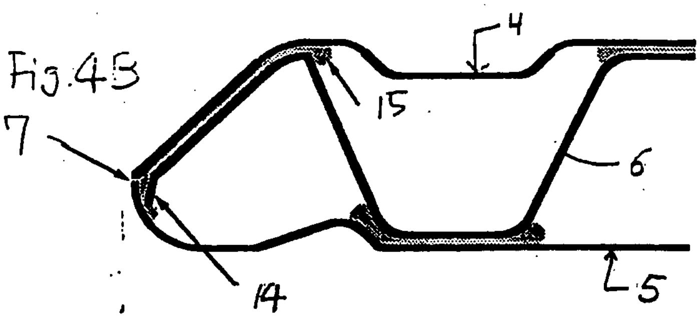


Fig. 5A

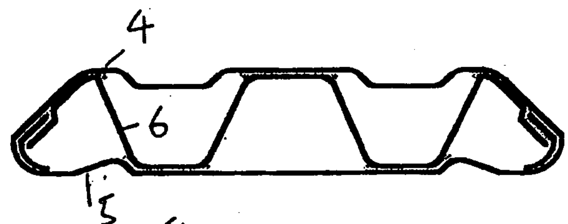


Fig 5B

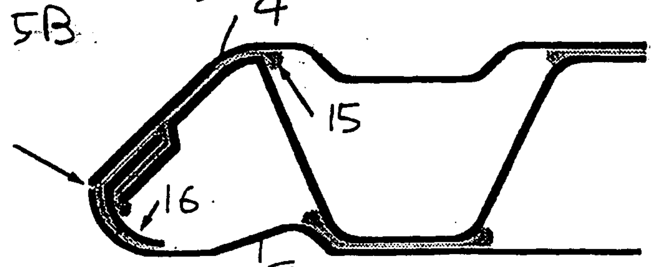


Fig 6A

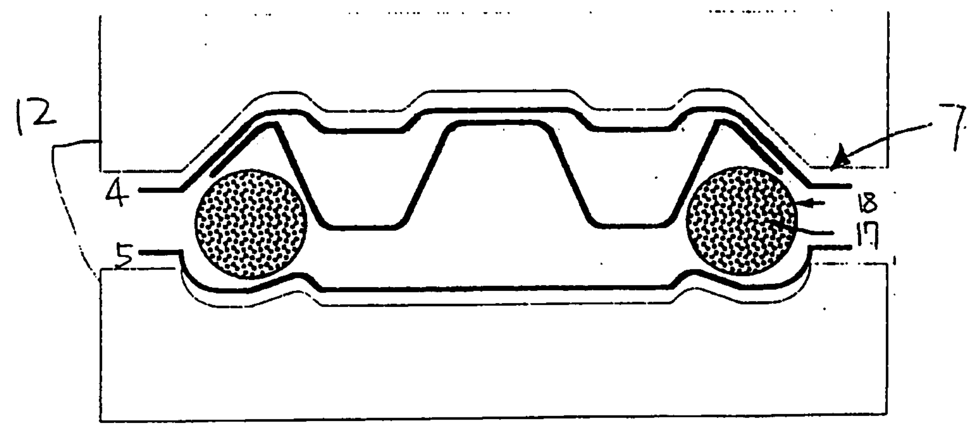


Fig. 6B

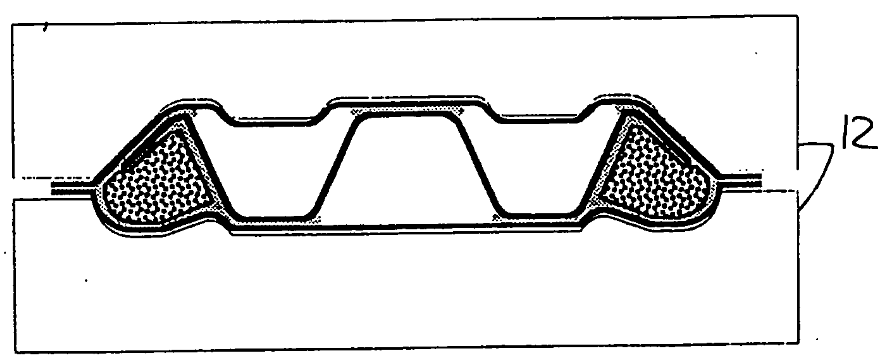
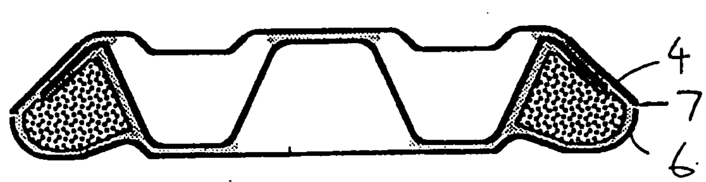


Fig. 6C



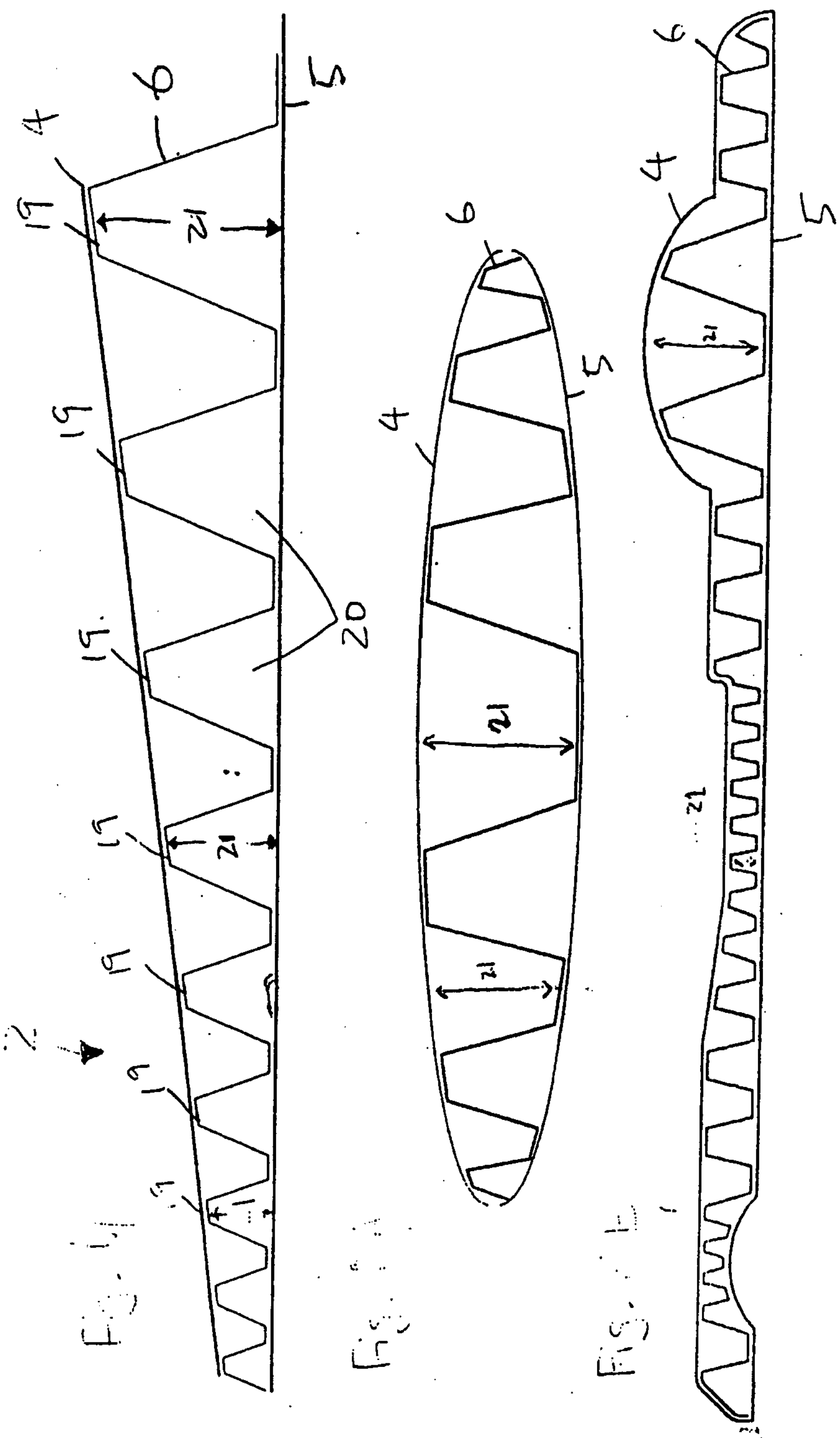

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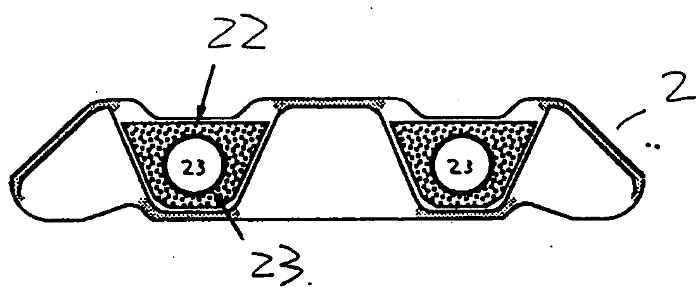
Fig 9



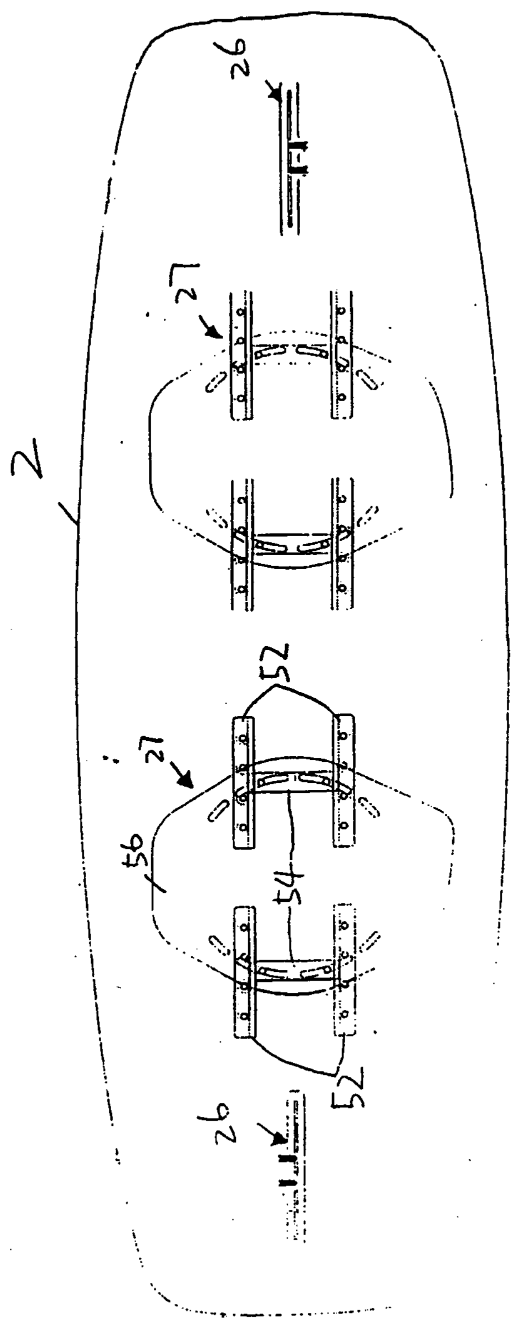


Fig. 10

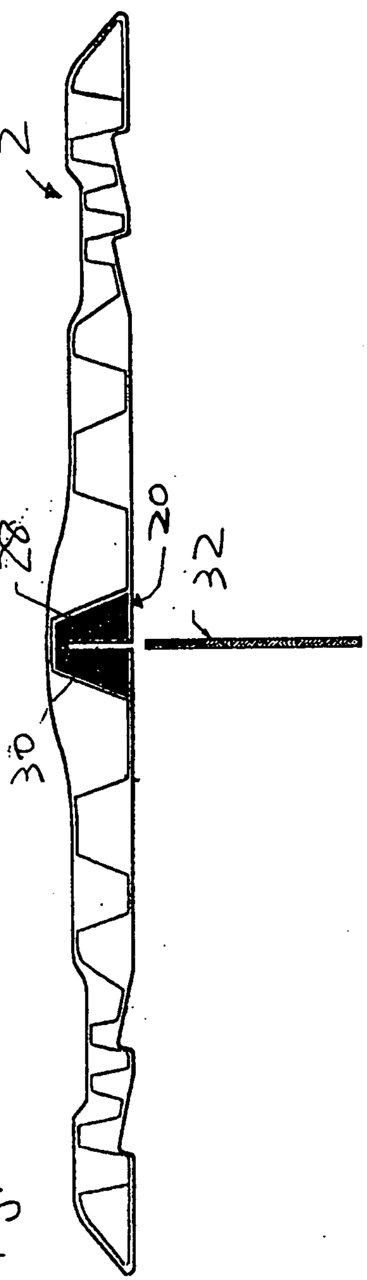


Fig. 11A

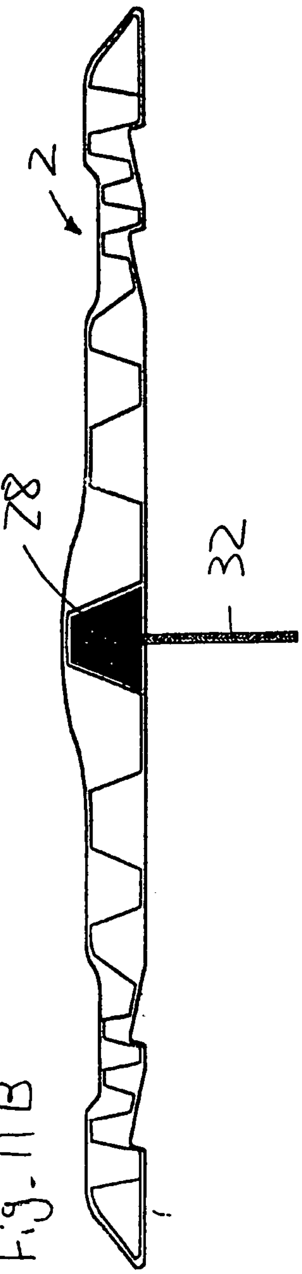


Fig. 11B

Fig 12A

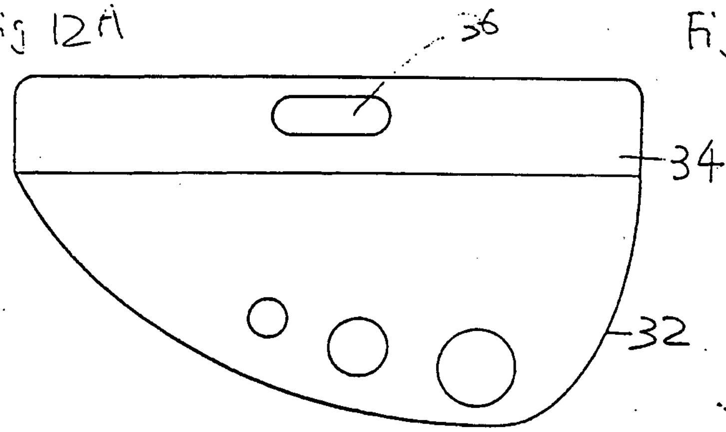


Fig. 12B

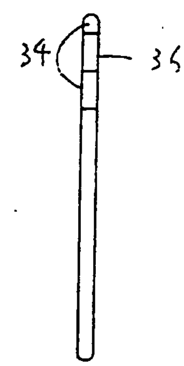


Fig 13A

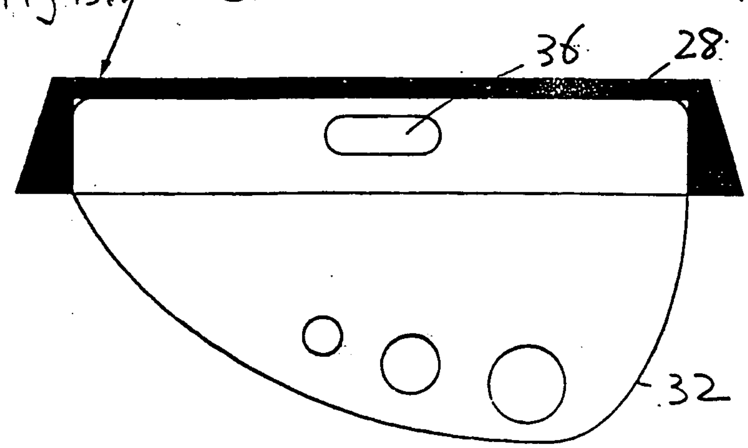


Fig. 13B

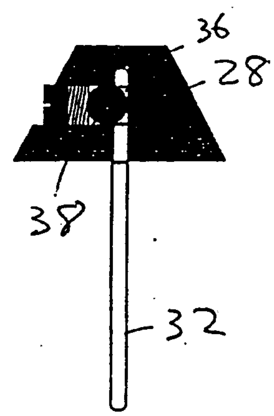


Fig. 14

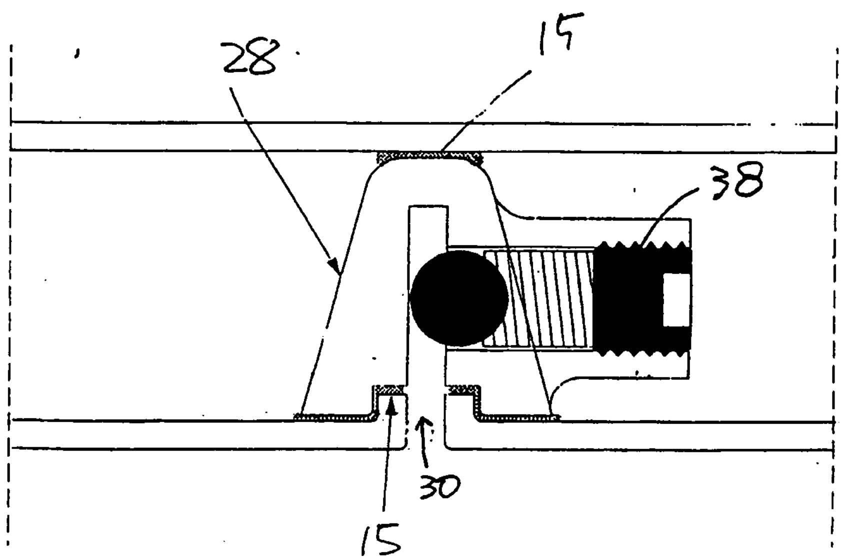


Fig. 15A

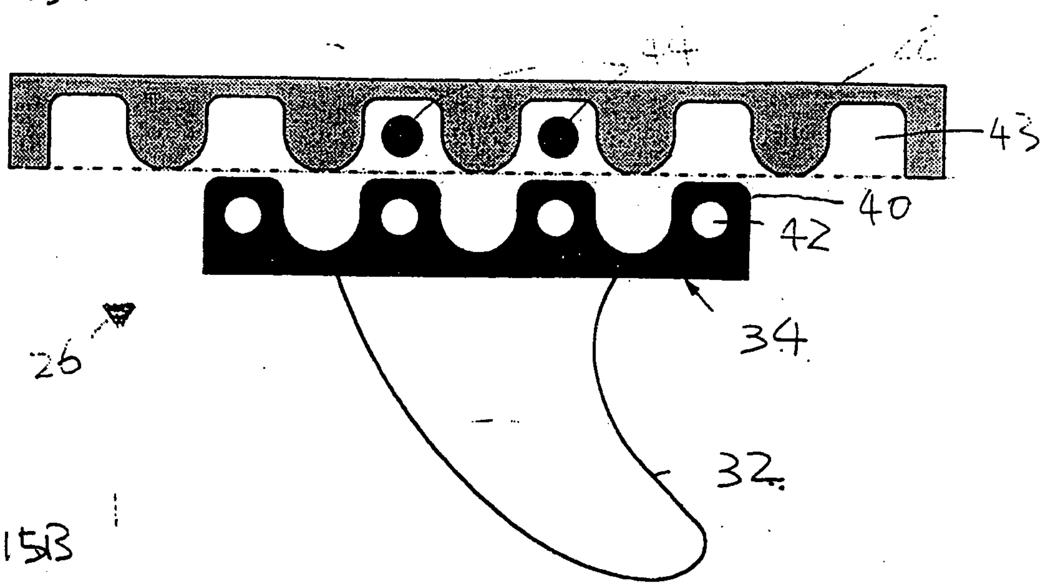


Fig. 15B

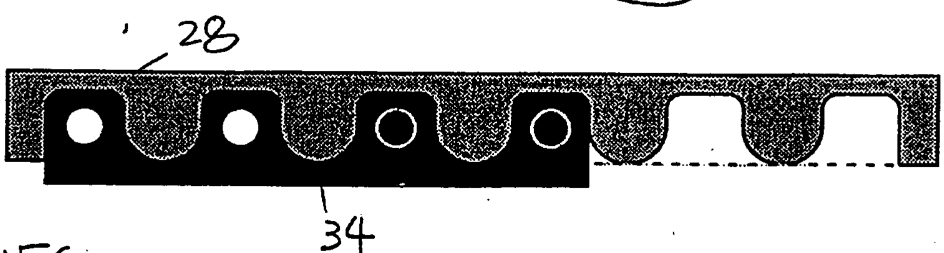


Fig. 15C

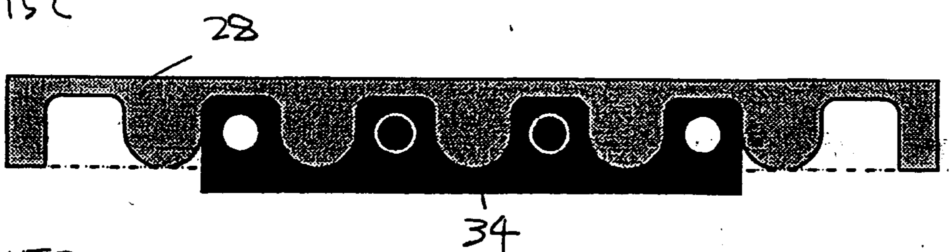


Fig. 15D

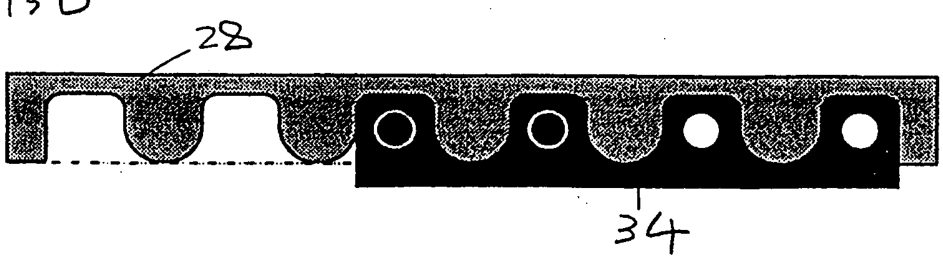


Fig. 16A

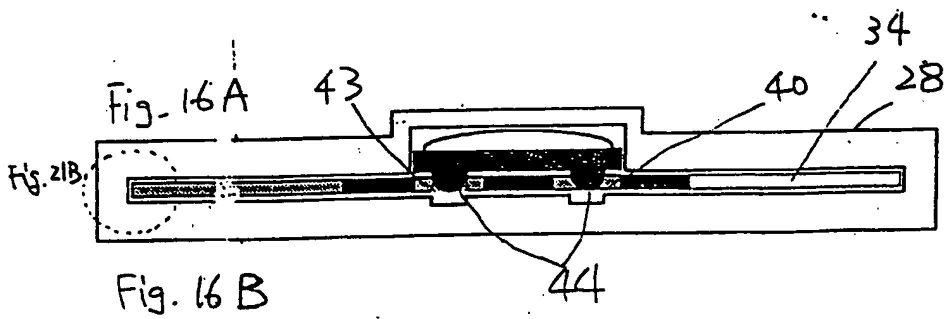
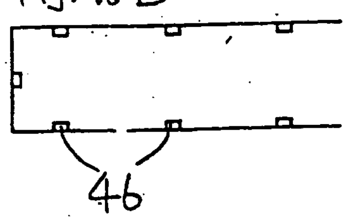


Fig. 16 B



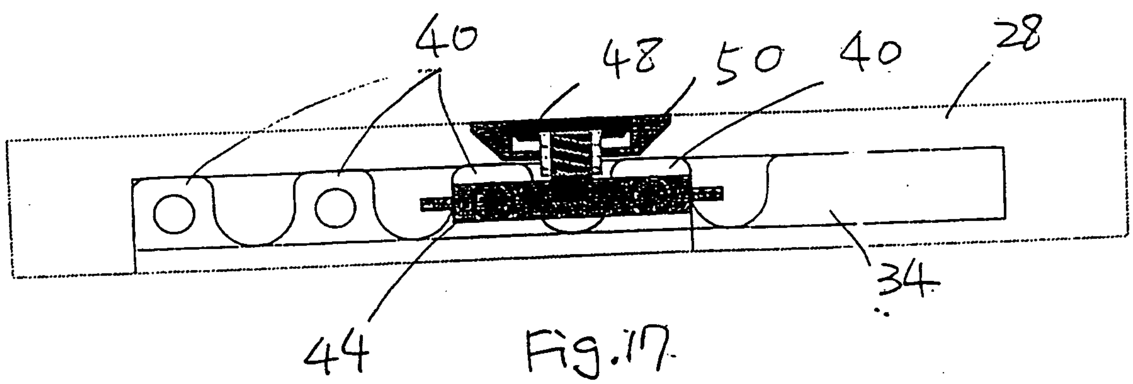


Fig. 17

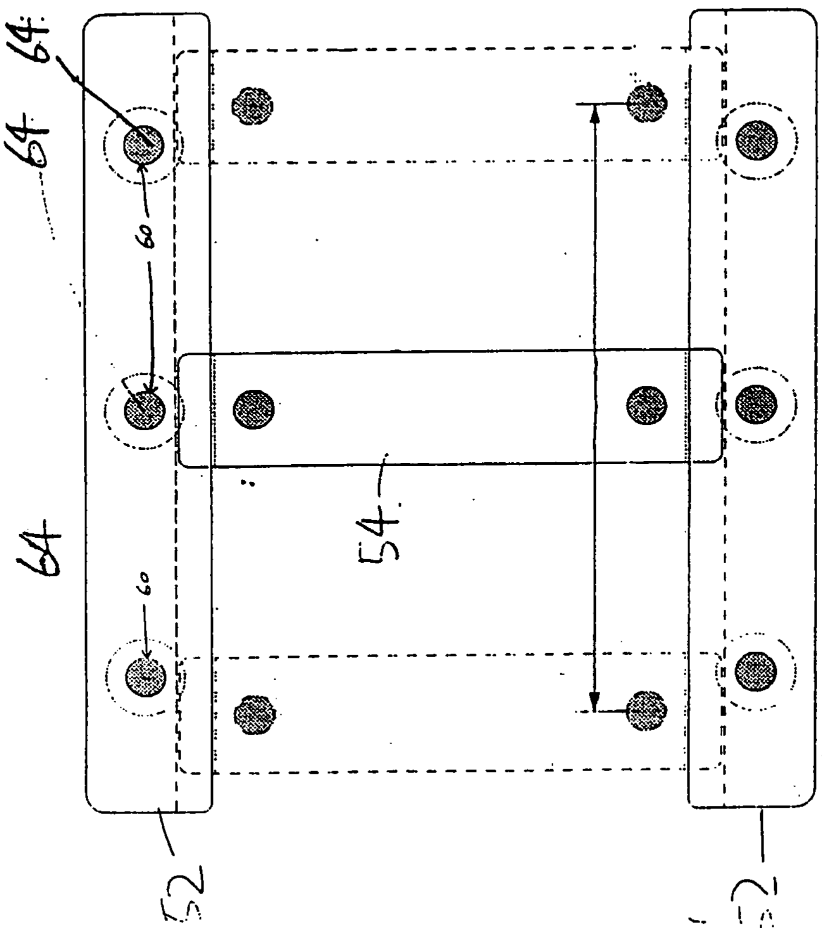


Fig 18

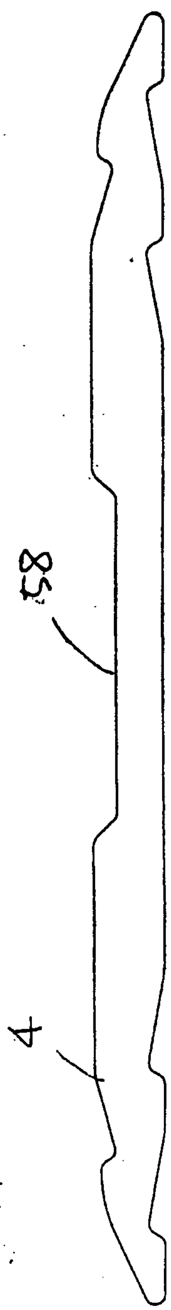


Fig. 19A

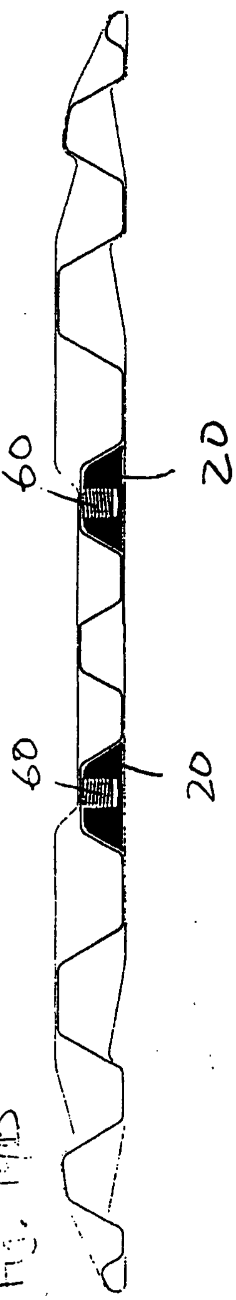


Fig. 19B

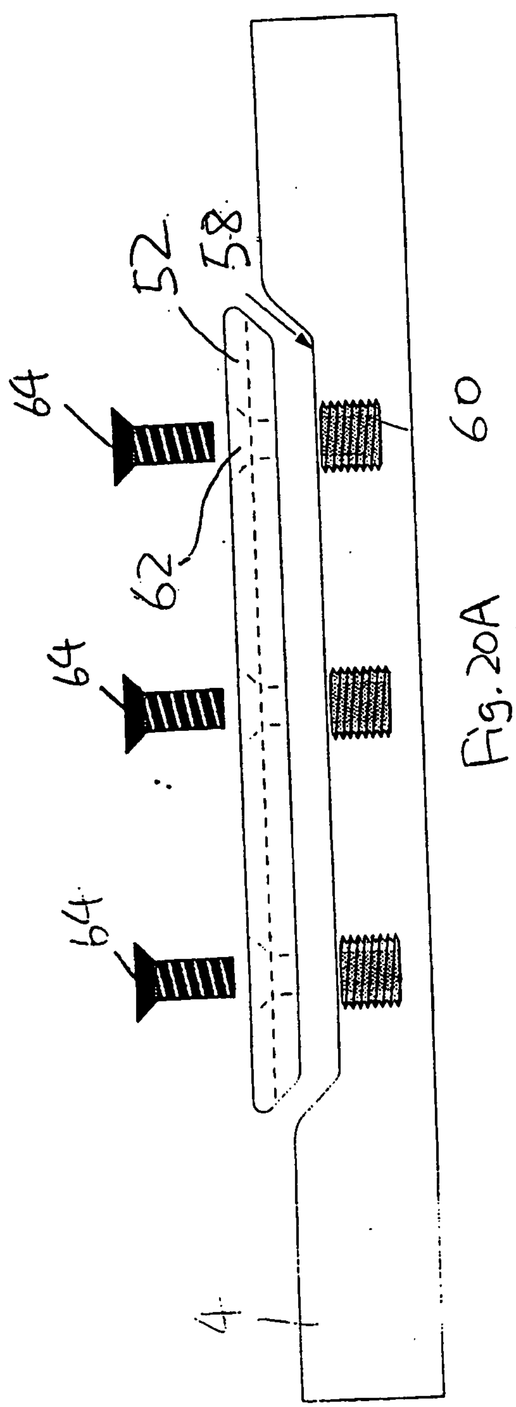


Fig. 20A

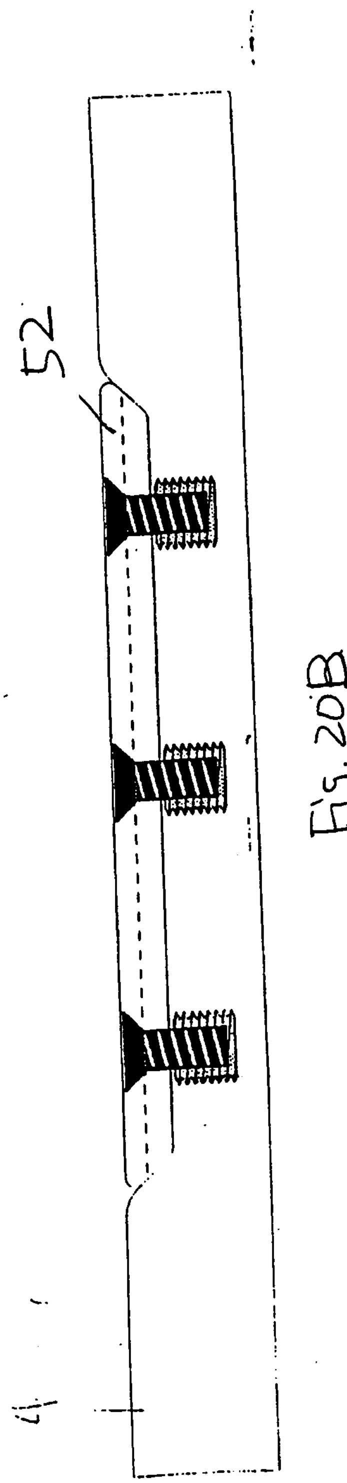


Fig. 20B

Fig. 21A

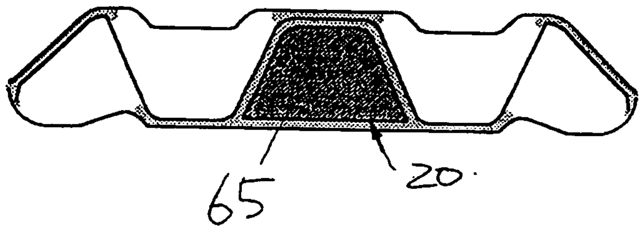


Fig. 21B

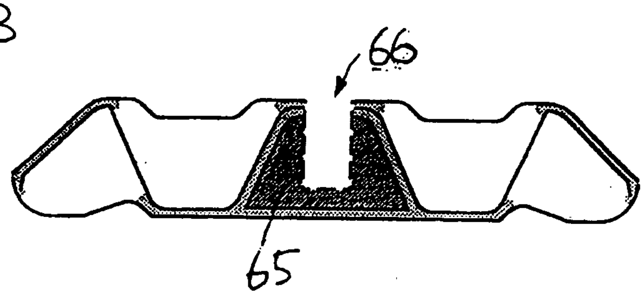


Fig. 21C

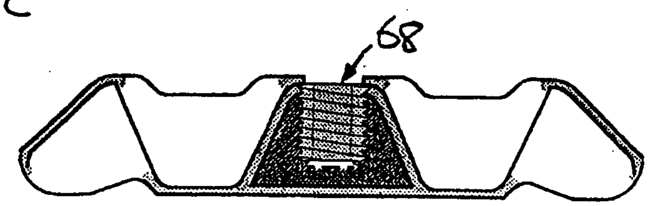


Fig. 22A

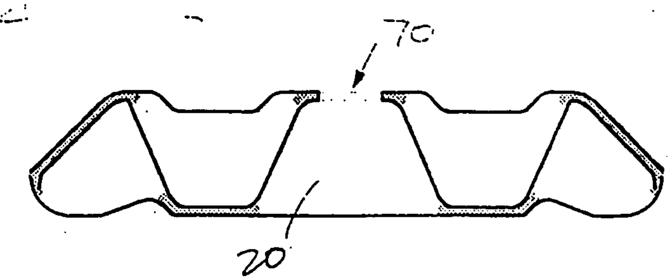


Fig. 22B

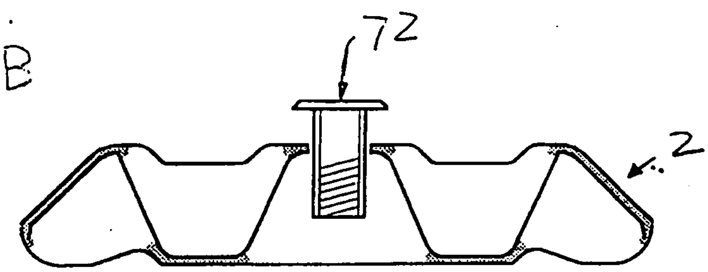


Fig. 22C

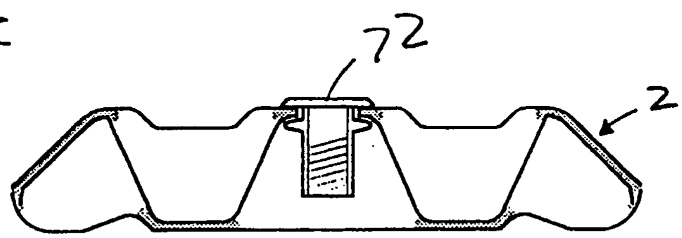


Fig. 22D

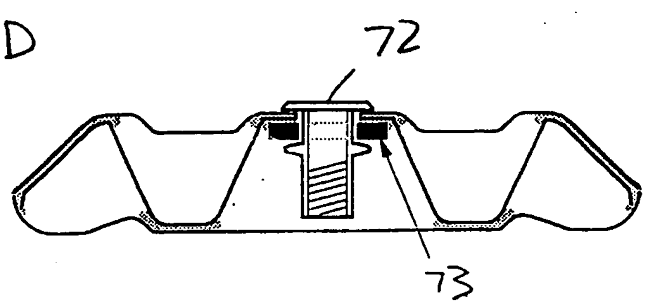


Fig. 23A

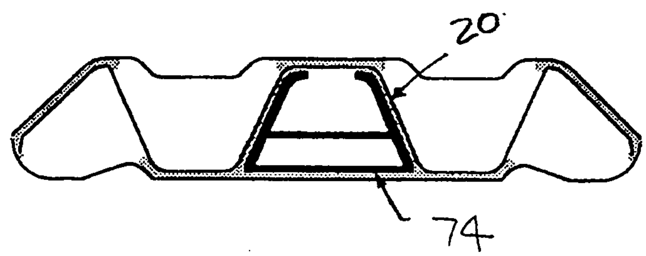


Fig. 23B

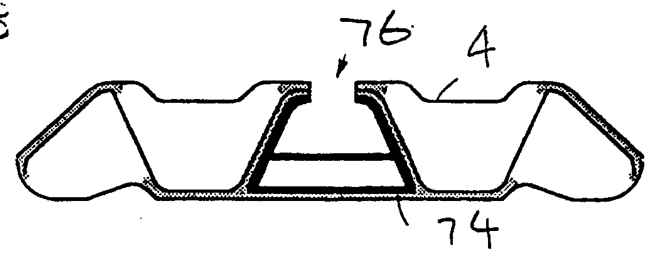
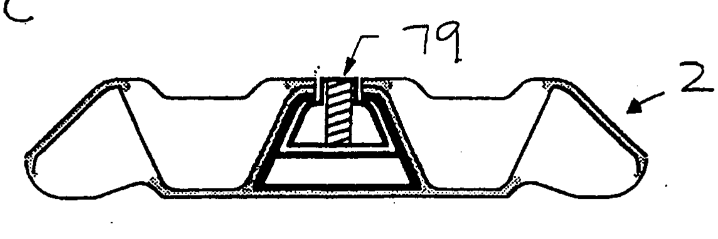


Fig. 23 C



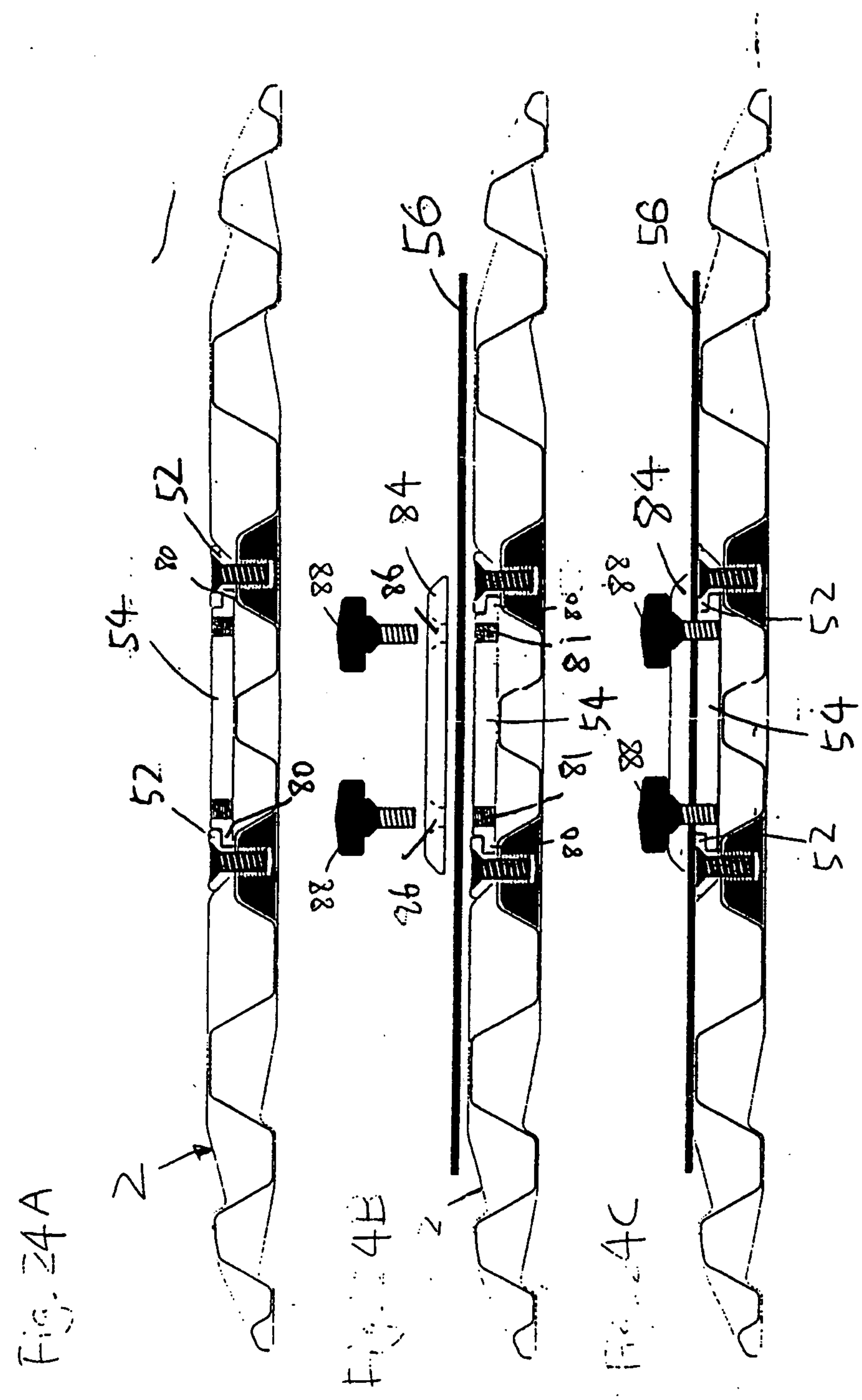
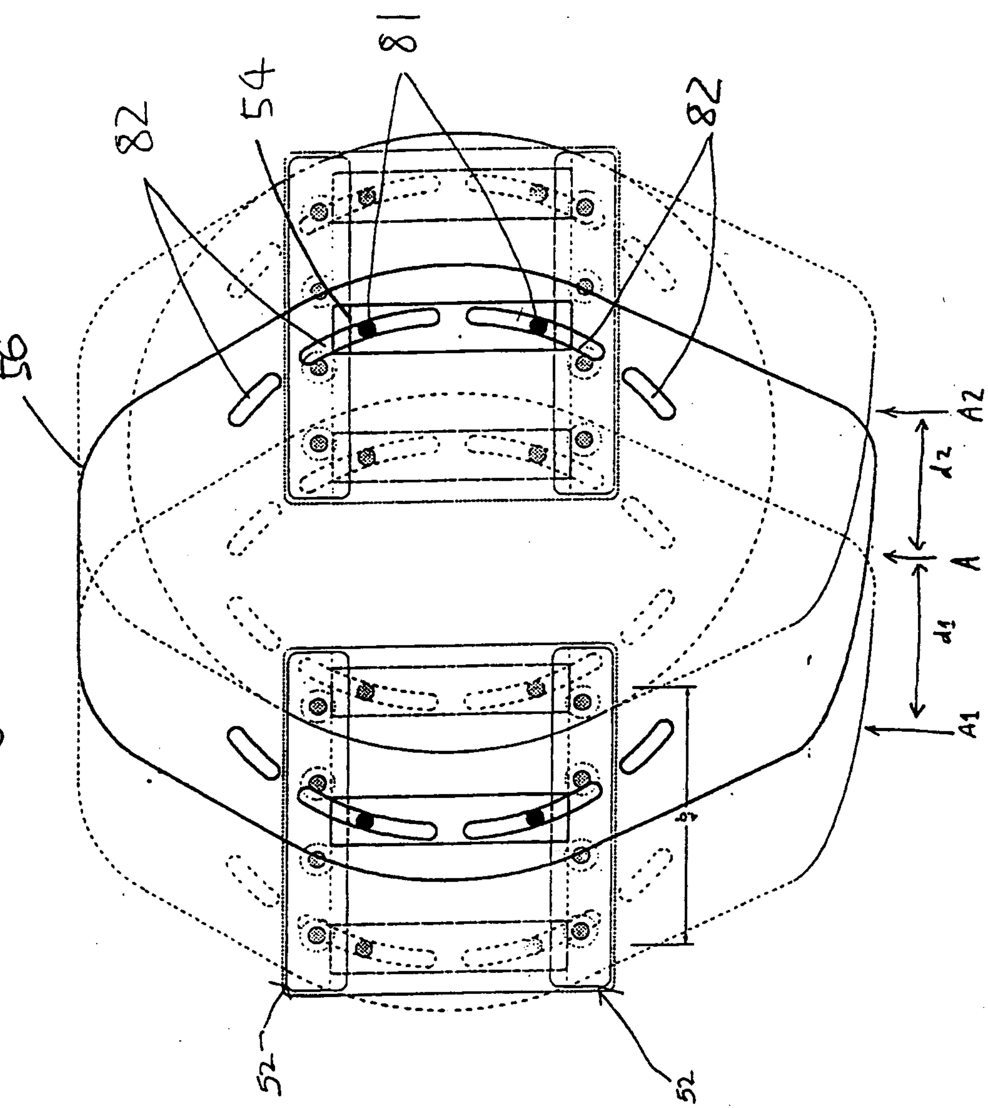


Fig. 24A

Fig. 4B

Fig. 4C

Fig. 25



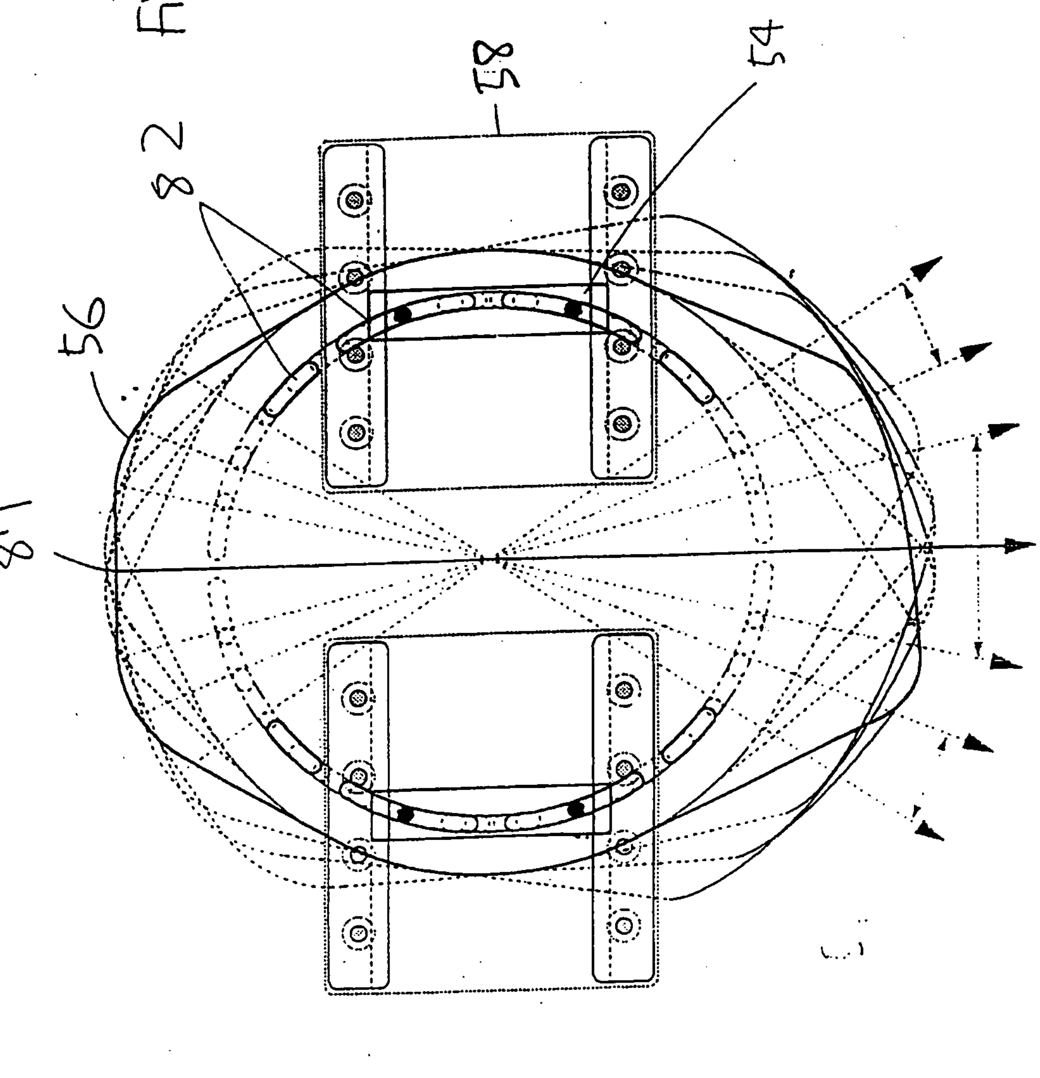


Fig. 26

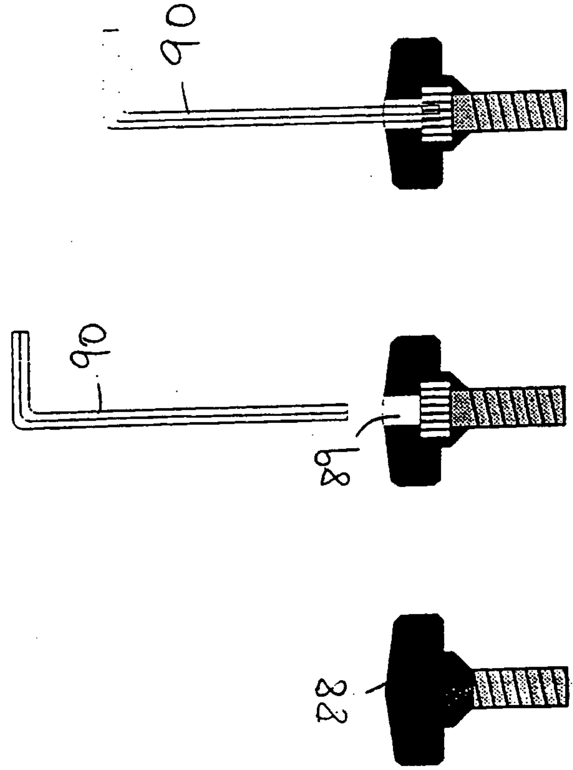


Fig. 27A
Fig. 27B
Fig. 27C

Fig. 28